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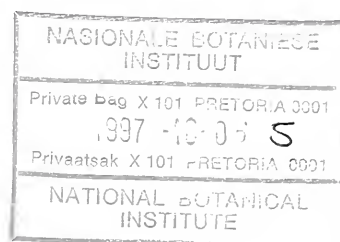
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BOTHALIA

A JOURNAL OF BOTANICAL RESEARCH

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A new species of *Nivenia* (Iridaceae)

P. GOLDBLATT*

Keywords: Iridaceae, new species, *Nivenia*, South Africa, taxonomy

Nivenia parviflora Goldblatt, sp. nov.

Plantae 0.3–0.5(–0.8) m altae, sempervirentes, caulibus pluribus e caudice lignoso compresso elliptico, foliis distichis ensiformibus ad linearibus usitate 50–70 × 3–4 mm, inflorescentiis ex rhipidiis binatis bifloris 20–60 compositis paniculam corymbosam formantibus, spathis 3–4 mm longis, bracteis siccis papyraceis corrugatis brunneis, floribus pallide caeruleis heterostylis, tubo perianthii ± 5.5 mm longo, tepalis subpatentibus lanceolato-ellipticis 6.3–7 × 2.4–3.0 mm, filamentis ± 6 mm longis (plantis brevistylis) vel ± 2 mm longis (plantis longistylis), antheris ± 1.3 mm longis pallide caeruleis, ovario ± 1.2 mm longo, stylo ± 2 mm (plantis brevistylis) vel 6–8 mm (plantis longistylis) ex tubo exserto, lobis stigmati ± 0.4 mm longis.

TYPE.—South Africa. Western Cape, Ladismith District, Klein Swartberg Mountains, slopes of Toringberg, ± 800 m, 25 Mar. 1996, *Goldblatt 10498* (NBG, holo.; BOL, K, MO, PRE, WAG, iso.).

Description

Shrubs 0.3–0.5(–0.8) m high, evergreen, bearing several branches from base. *Stems* few and irregularly branched, leafy terminal branches compressed, ± 3 mm at widest diameter. *Leaves* forming a distichous fan, narrowly lanceolate to nearly linear, mostly 50–70 × 3–4 mm, veins not evident when alive. *Inflorescence* a corymbose pseudopanicule of 40–120 flowers in 20–60 flower pairs, peduncles exserted from leaves, compressed and 2-winged, 3.0–4.5 mm wide, ultimate branches bearing paired flowers within opposed spathes; *spathes* 3–4 mm long, outer slightly larger than inner, coriaceous, reddish brown, sometimes green near bases, dry and dark brown above; *floral bracts* dry, reddish brown, much wrinkled, ± 5 mm long. *Flowers* hypocrateriform, heterostylous, mostly pale blue, occasionally middle blue (rarely white), white at base of tepals and in tube; *perianth tube* cylindric, ± 5.5 mm long; *tepals* subpatent, held ± 30° above horizontal, lanceolate-elliptic, 6.3–7.0 × ± 2.4–3.0 mm. *Filaments* filiform, suberect, inserted just below top of tube, either ± 6 mm long (thrum morph) or ± 2 mm long (pin morph); *anthers* submedianly fixed, becoming versatile, ± 1.3 mm long, pale blue, pollen whitish. *Ovary* ovoid-turbinate, ± 1.2 mm long; style filiform, either emerging ± 2 mm from tube (thrum morph) or 6–8 mm from tube (pin morph), apically divided into three linear stigma lobes,

each ± 0.4 mm long. *Capsules* ovoid, ± 5 mm long, somewhat pinched near apex, with one seed per locule and usually only one locule fertile. *Seeds* tangentially compressed, blackish with transparent outer coat, surface rugose, 3.0–3.5 mm long. Flowering March to May. Figure 1.

Distribution and habitat

Nivenia parviflora is restricted to the lower southern slopes of the Klein Swartberg Mountains near Ladismith in Western Cape Province, South Africa. Plants grow on rocky sandstone slopes, mostly in rock outcrops, in fynbos vegetation in a community with *Protea repens* L. a dominant species. As in most species of *Nivenia*, flowering occurs in the late summer and autumn, March and April to early May for *N. parviflora*. Its close relative, *N. binata*, is one of only two species of the genus that flowers in the spring, August to October, the other being the taxonomically isolated *N. argentea* Goldblatt.

Diagnosis and relationships

Comprising 10 species, including this new species, *Nivenia* is one of three genera of the Iridaceae that are evergreen shrubs with truly woody stems that produce secondary growth. *Nivenia* and the two other shrubby genera, *Klattia* (three species) and *Witsenia* (one species) are a clade within subfamily Nivenioideae, one of four subfamilies of the Iridaceae, that also includes the African *Aristea*, the Madagascan *Geosiris*, and the Australasian *Patersonia* (Goldblatt 1990, 1993). All three shrubby genera are restricted to the Cape Flora Region of southern Africa. The three shrubby genera form a clade defined not only by their woody and evergreen habit, but by several other specialized features, including leaves with sclerenchyma strands, inflorescence units two- or one-flowered, ovules two per locule, tangentially flattened, shield-shaped seeds, and a transparent testa (Manning & Goldblatt 1991). Within this clade *Nivenia* has the least specialized flowers, always with a blue perianth, the majority of species are distylous, and the floral bracts are dry and papery. Out-group comparison indicates that both distyly and the dry bracts are derived and thus ancestral traits for the genus.

Within *Nivenia* the majority of species have the individual inflorescence units (binate rhipidia) arranged in corymbose pseudopanicles and the rhipidial spathes are short and obtuse. Among these are the new *Nivenia parviflora* which has, in addition, derived dark brown and much wrinkled floral bracts and blue anthers, features shared by two other species of *Nivenia*, *N. binata* Klatt and *N. stenosphon* Goldblatt. It is to these species that *N. parviflora* is evidently most closely related. Both *N. binata* and

* B.A. Krukoff Curator of African Botany, Missouri Botanical Garden, P.O. Box 299, St. Louis, Missouri 63166, U.S.A.

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Artist: F. ANDERSON, 6 Murray Rd, Kenilworth, 7700 Cape Town.

N. stenosphon have larger flowers with tepals 7.5–12.0 mm long, and a longer perianth tube, usually 10–15 mm long in *N. binata* and 32–38 mm long in *N. stenosphon*. *Nivenia parviflora* contrasts with both of these in its unusually small flowers, the tepals 5–6 mm long and the tube \pm 5.5 mm long. Because of the smaller flower and relatively short perianth tube of *N. binata* we suggest that *N. parviflora* may be most closely related to that species. Differences between them extend beyond the size and proportions of the floral parts. The rhipidial spathes are 4–5 mm long and the floral bracts 9–10 mm long in *N. binata*, substantially longer than in *N. parviflora* which has spathes 3–4 mm long and floral bracts \pm 5 mm long. The differences are presumably directly related to the smaller flowers of the species. Also presumably associated with the small flower size, the filaments and styles of *N. parviflora* are shorter than those of *N. binata*. The filaments are either \pm 2 mm or \pm 6 mm long (for long- or short-styled morphs) and the styles are either 4 mm longer or shorter than the stamens in *N. parviflora* whereas in *N. binata* the filaments are either 2–3 or 7–9 mm long (for long- or short-style morphs) and the styles either 5–6 mm longer or shorter than the stamens.

Pollination and evolution

The small flower and short perianth tube of *Nivenia parviflora* are related to its pollination ecology. The flowers are visited by and presumably pollinated by the medium-sized bee, *Amegilla* sp. (Anthophoridae), the fly *Prosoeca* sp. (Nemestrinidae), and the butterfly, *Cynthia cardui*. The flowers produce small amounts of nectar in the base of the perianth tube on which the insects feed. Mouthparts of *Amegilla* sp. and *Prosoeca* sp. are 7–8 mm and \pm 10 mm long respectively. Thus both these insects are able to remove nectar from the base of the tube of *N. parviflora* which is \pm 5 mm long. While foraging for nectar in flowers of *N. parviflora* the bodies of these insects brush against the exerted anthers, and pollen is deposited on their bodies. Pollen of short-styled plants, thus with long stamens, is dusted on an insect's ventral and lateral thorax and abdomen but mainly on the frons in long-styled plants with short stamens. When insects visit flowers with long styles, the terminal stigmas brush against its abdomen and lower thorax thus becoming dusted with pollen from the short-styled morph. Heterostyly thus promotes outcrossing by differential pollen placement on the body of a pollinating insect and this is accompanied by contact with the complimentary stigma type.

The closest relatives of *Nivenia parviflora*, *N. binata* and *N. stenosphon* are both restricted to the Swartberg Mountains, and the adjacent Touwsberg in the case of *N. stenosphon*, and both are pollinated by long-tongued flies of the genus *Prosoeca* (Nemestrinidae) (Goldblatt & Bernhardt 1990). The difference in flower size in *N. parviflora* which is correlated with a pollination strategy different

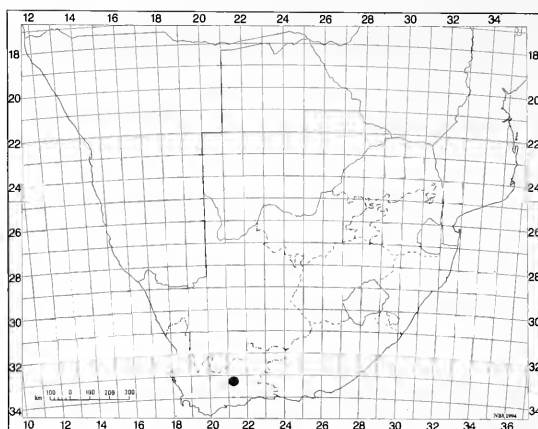


FIGURE 2.—Distribution of *Nivenia parviflora*.

from that of its two relatives, and a difference in flowering time between *N. parviflora* and *N. binata*, presumably sister species, makes it desirable to recognize it as a distinct species. The ranges of the three Swartberg species of *Nivenia* are complimentary, *N. stenosphon* occurring west of Ladismith, *N. parviflora* with a narrow range north of Ladismith, and *N. binata*, with the widest range, extends from Seweweekspoort east of Ladismith to Meiringspoort. It seems clear that both geographic and seasonal components are involved in the radiation and speciation within this clade and in differences in their pollination ecology.

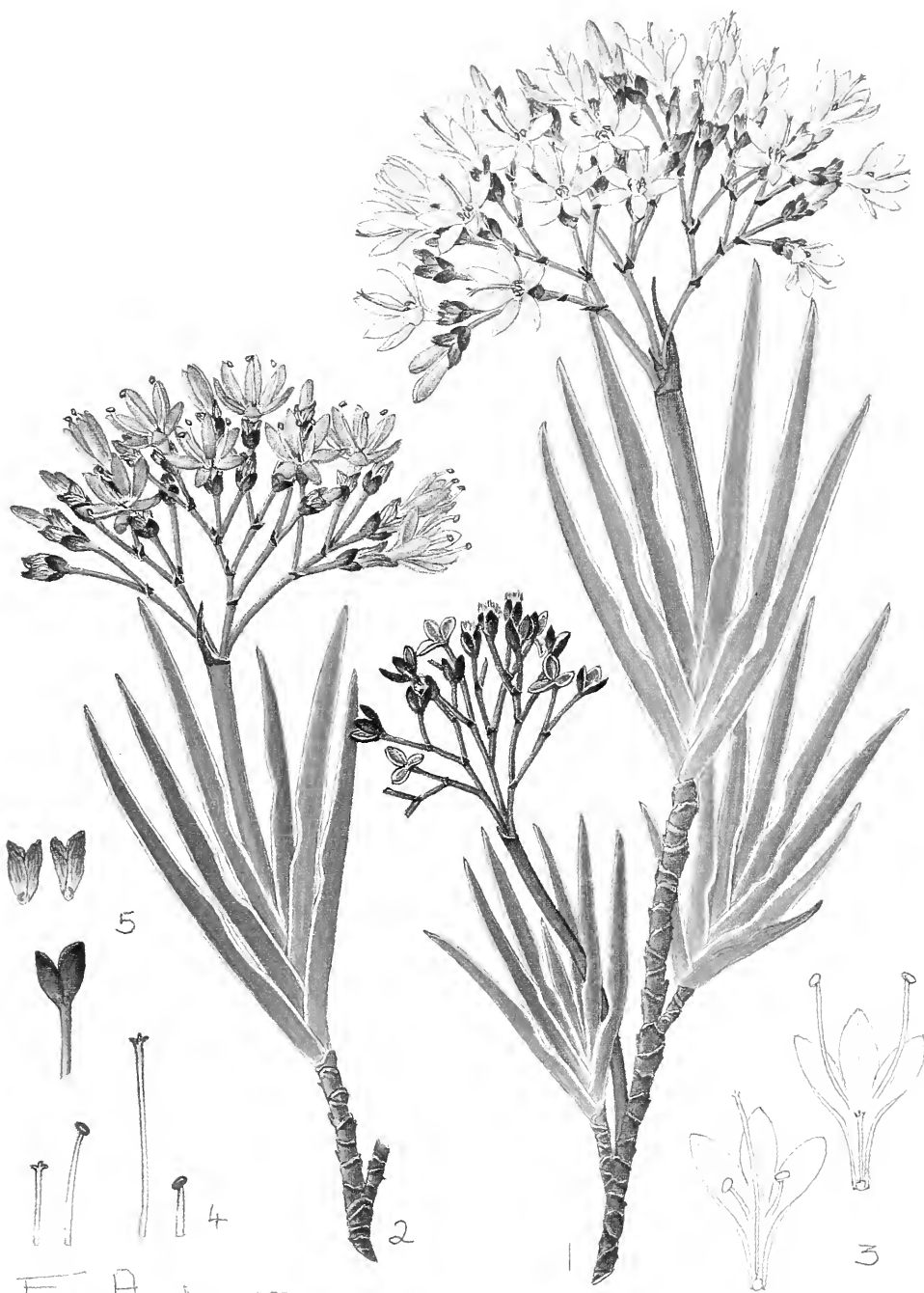
History

Nivenia parviflora was apparently first collected by the botanist and intrepid collector, Elsie Esterhuysen in 1947 in fruiting condition. This collection, and a flowering one made in 1951, were referred to *N. binata* in my monograph of the genus (Goldblatt 1993) because I thought that the specimens represented odd plants flowering out of season and with somewhat smaller flowers than normal. Additional collections show that this assumption was wrong. The plants have a separate geographical range from that of *N. binata* and consistently have smaller flowers that bloom in autumn.

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FIGURE 1.—*Nivenia parviflora*, Goldblatt 10498 (BOL, K, MO, NBG, PRE, WAG). 1, flowering stalk of a long-styled plant, \times 1; 2, flowering stalk of a short-styled plant, \times 1; 3, half flowers showing position of style and stamens in long- and short-styled morphs, \times 2; 4, relative lengths of style and stamen of a short-styled flower (left) and a long-styled flower (right), \times 2; 5, inflorescence spathes of a single binate rhipidial and floral bracts of two flowers contained therein, \times 2. Artist: Fay Anderson.



Fay Anderson.



Studies in the liverwort genus *Fossombronina* (Metzgeriales) from southern Africa. 4. A re-examination of *F. crispa*, *F. leucoxantha* and *F. tumida*

S.M. PEROLD*

Keywords: *Fossombronina*, *F. crispa*, *F. leucoxantha*, *F. tumida*, Hepaticae, Metzgeriales, southern Africa

ABSTRACT

The above three southern African species were described during the nineteenth century, but the descriptions are brief and mostly inadequate. The practice, albeit for justified financial reasons, of dividing collections (which were often mixed) and of distributing the parts to different herbaria, has led to some later authors applying the specific epithets to the wrong components. This has caused a great deal of confusion, and much time and effort have been expended in sorting out these misapplications. This paper aims to correct and to report on some past mistakes. Detailed descriptions, illustrations and a distribution map of these three species are accordingly provided.

1. ***Fossombronina crispa*** Nees in Synopsis Hepaticarum, Gottsche et al.: 469 (1846). Type: Cap. de b. Spei, leg. presumably *Zeyher*, no collector's name on label, only the number 3, probably added later (STR, lecto.! fide Perold 1997d).

Jungermannia crispa Sprengel in schedule Herb. Zeyher.

J. pusilla Lehm. : 369 no. 42, Ecklon (BM!).

Fossombronina zeyheri Steph.: 32 (1900); Sim: 35 (1926); S.W. Arnell: 79 (1963); Sérgio: 191 (1985). Type.—Cap. b. spei, leg. *Zeyher* s.n. G024669(G!) ex Herb. Rabenhorst, idem ex Herb. (?)ope, G024670(G!), portion(s) of type, sub *F. crispa*.

Plants in dense colonies, pale green or bright green to glaucous green; medium-sized to robust; shoots simple, (8–)12–15 mm long, 1.5–2.0 mm high, 3.2–3.4 mm wide, or once/twice or repeatedly furcate, terminal segments moderately divergent, 3.0–5.0 mm long. *Stems* prostrate, chlorophyllose, sometimes outer cells purple, occasionally with a lateral bud, later developing into a side shoot, plano-convex in cross section, apically frequently swollen, 320–350 µm (13 cell rows) high, 500–540 µm wide (Figure 1G), tapering proximally and toward base (Figure 1H), 220–230 µm high, 270–300 µm wide. *Rhizoids* purple, 12.5–22.5 µm wide. *Leaves* (Figure 1A–F) overlapping, widely spreading to suberect (Figure 2A), slightly undulate to crispate, succubously inserted, apically small, soon enlarging, oblong to irregularly rectangular, somewhat longer than wide or occasionally as long as wide or even shorter than wide; 1450–1950 × 1250–2000 µm, often narrower below, 750–1375 µm; apex rounded or truncate, sometimes 2 or 3 times slightly notched and shallowly lobed, margins (Figure 1I) entire, but with 7–14 unicellular slime papillae, generally well spaced, but at proximal (trailing) edge closer together and occasionally raised on a basal cell. *Leaf cells* thin-walled, at upper margins mostly rectangu-

lar across, 10.0–37.5 × 42.5–75.0 µm, at lateral margins long-rectangular, 67.5–80.0 × 15.0–22.5 µm, upper laminal cells 5- or 6-sided, 50.0–57.5 × 37.5–52.5 µm, middle laminal cells 87.5–107.5 × 35.0–45.0 µm, basal cells 120.0–137.5 × 30.0–47.5 µm. *Oil bodies* variable in number, 9–45 per cell, round, smooth or granular, up to 5 µm in diameter (Figure 1J); chloroplasts numerous, crowded, ± 5 µm in diameter (Figure 1J).

Monoicous (Figure 2B, C), sometimes seemingly dioicous. *Antheridia* short-stalked, globose, dorsal on stem, sometimes crowded together near apex of shoot, interspersed with the younger archegonia and apparently naked (Figure 2B), at other times proximal to pseudoperianth (or on different plants) and subtended by perigonial bracts (Figure 2D), their shape irregular (Figure 1K–N), 400–850 × 250–450 µm wide across broadest part, mostly narrower toward apex and base, margins with up to 7 papillae or with 1 or 2 short, finger-like processes, cells in interior 5- or 6-sided, 112.5–117.5 × 30.0–42.5 µm, marginally 32.5–50.0 × 20.0–50.0 µm. *Archegonia* in 1 or 2 irregular rows along stem, even extending toward base (Figure 2A), naked, sometimes 2 in close proximity becoming fertilized (Figure 2E). *Pseudoperianth* campanulate (Figure 1O, P), at apex of branch or close to it, as tall as, or up to 375 µm taller than leaves, raised on a short stalk, 375–500 µm long, 550–600 µm wide, then widely flaring upwards, 1625–2150 µm long, 2500–2925 µm wide across mouth, margin with ± 5 main undulating lobes (Figure 2F), generally subdivided into smaller ones, at side mostly cleft once to base, often with lamellar outgrowths, 1125–1375 × 375 µm; cells not appreciably different from those of leaves. *Capsules* globose, ± 550 µm in diameter, wall bistratose, cells of inner layer irregularly shaped, 25.0–75.0 × 20.0–35.0 µm, each cell wall with 3 or 4 dark brown nodular and occasionally semi-annular thickenings (Figure 1R). *Seta* 2.9–4.4 mm long, ± 150 µm in diameter, ± 7 cell rows across (Figure 1Q). *Spores* light brown, 37.5–42.5 µm in diameter, including lamel-

* National Botanical Institute, Private Bag X101, Pretoria 0001.
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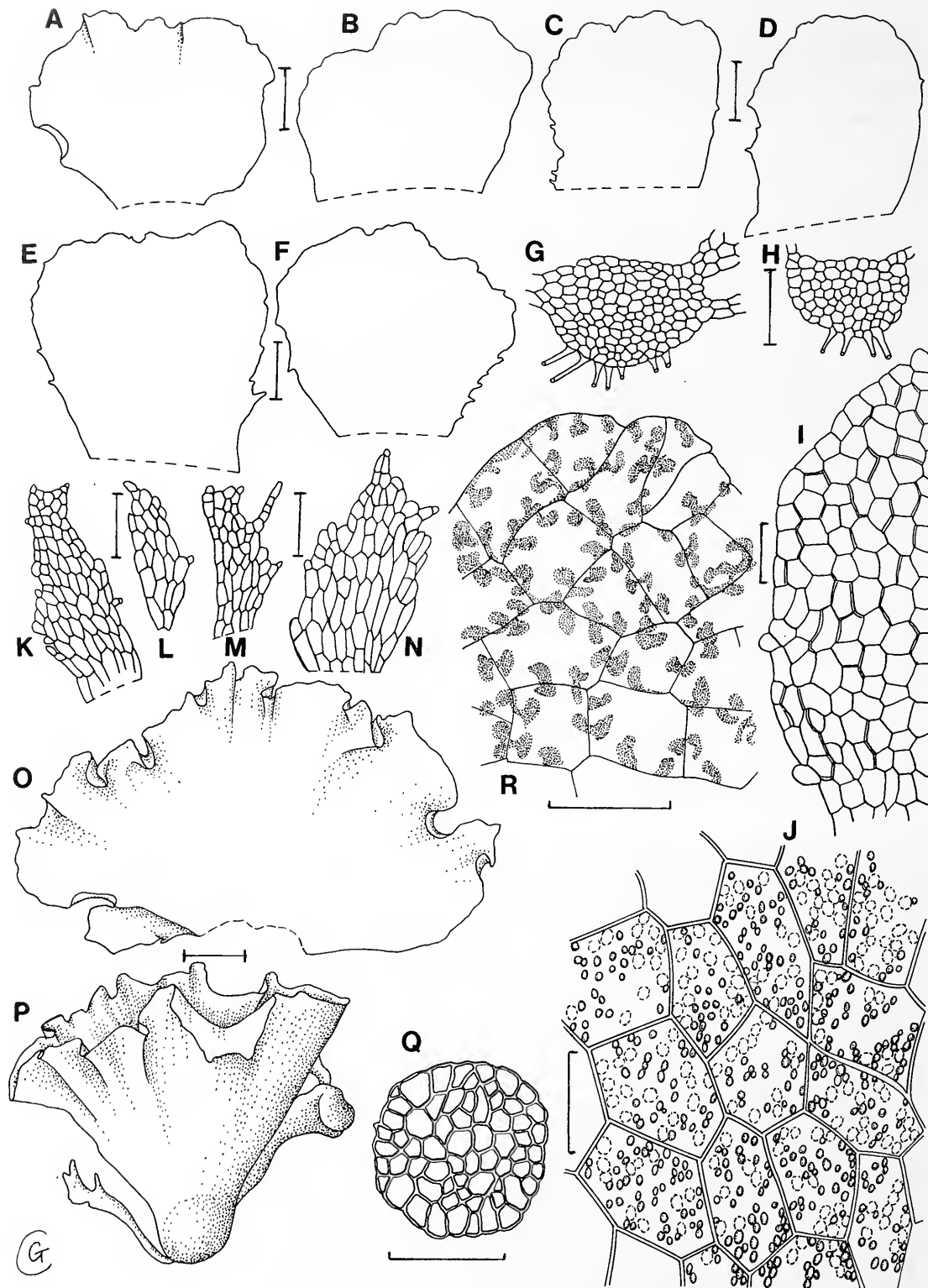


FIGURE 1.—*Fossombronina crista*; A–F, leaves; G, cross section of stem apex; H, cross section of stem base; I, detail of leaf margin; J, median leaf cells with oil bodies (solid lines) and chloroplasts (dotted lines); K–N, bracts; O, opened pseudoperianth; P, pseudoperianth from side; Q, cross section of seta; R, cells in capsule wall. A, C–F, K–P, *S. Strauss 134a*; B, I, J, *S. Strauss CH13664*; G, H, R, *Perold & Van Rooy 3558*; Q, *J. Victor 1379*. Scale bars: A–F, O, P, 500 μ m; G, H, K–N, 250 μ m; I, J, R, 50 μ m; Q, 100 μ m. Artist: G. Condy.

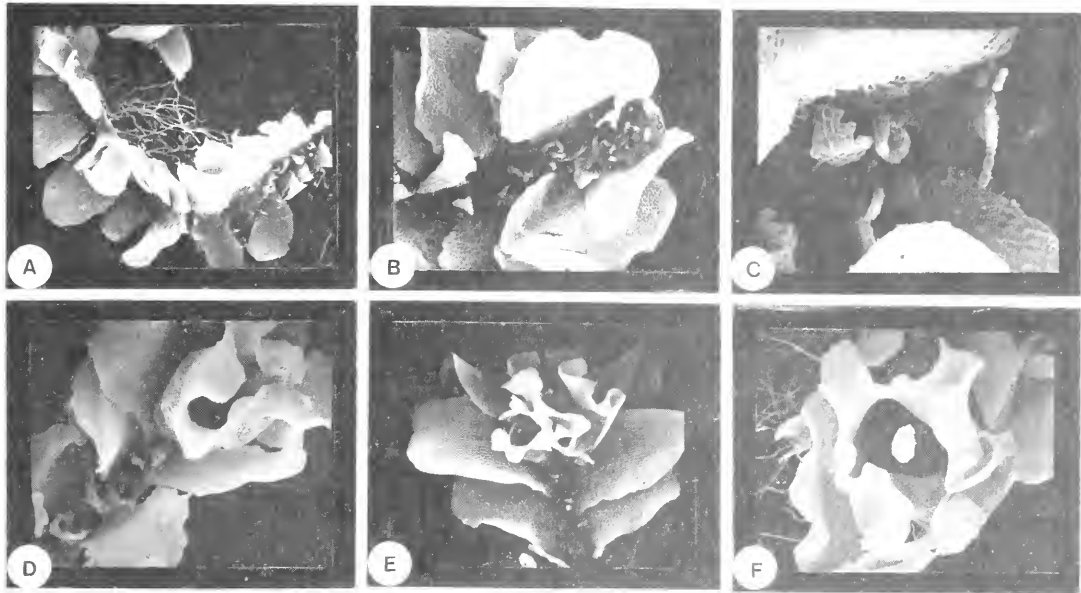


FIGURE 2.—*Fossombronina crista*. A, simple stem, leaves widely spreading; B, apex of segment with crowded antheridia and archegonia, more distally; C, apex of stem with naked antheridia, archegonia and a bract; D, pseudoperianth near apex of stem and bracts more proximally; E, two adjacent pseudoperianths; F, pseudoperianth from above. A, E, *S.M. Perold* 3444; B, *Perold & Koekemoer* 3282; C, *S.M. Perold* 3280 p.p.; D, F, *S. Strauss* 134a. A, $\times 7$; B, $\times 13$; C, $\times 41$; D, $\times 15$; E, $\times 8$; F, $\times 19$.

lae projecting around periphery; hemispherical; distal face (Figure 3A, B) convex, ornamentation over polar area reticulate or partly reticulate, low, slightly wavy lamellae forming ± 6 complete and incomplete, irregular areolae across diameter of face (a total of 15–24), each 7.5–12.5 μm wide, sides of lamellae with a few faint buttressing striations that soon disappear, spore surface between lamellae granular (Figure 3C); proximal face lacking triradiate mark, flat, covered with fine, low

ridges forming very small, irregular areolae, with papillae here and there (Figure 3D), otherwise very coarsely granular, toward centre of face granules coalescing into large, irregular clumps (Figure 3E), around spore periphery 14–18 low 'spines', which are the 'ends' of the lamellae from the distal face extending over the sides and are connected by a low, much interrupted, membranous wing or perispore. *Elaters* (Figure 3F) yellow-brown, 60.0–122.5 μm long, 7.5–12.5 μm wide in cen-

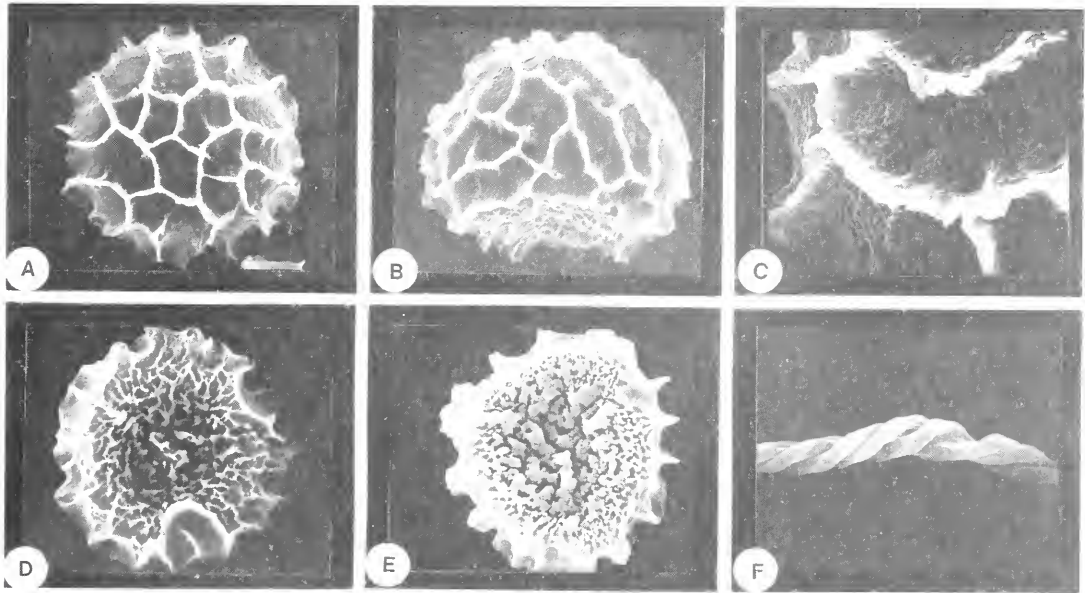


FIGURE 3.—*Fossombronina crista*. A–E, spores: A, distal face; B, side view of distal face; C, detail of lamellae and surface on distal face; D, E, proximal face. F, elater. A, D, *S.M. Perold* 3317; B, *S.M. Perold* 3280 p.p.; C, *S.W. Arnell* 2201; E, *S.M. Perold* 3444; F, *Perold & Van Rooy* 3558. A, $\times 725$; B, $\times 859$; C, $\times 2596$; D, $\times 705$; E, $\times 685$; F, $\times 852$.

tre, tapering to one or both tips and ending in a 5 µm wide loop, or not tapering, ends blunt, with 2 or 3 loose spirals or tightly coiled.

Fossombronia crispa grows on soil at river banks, seepage areas and at road sides. Although fairly frequently sterile, it is, nevertheless, the most common southern African species of *Fossombronia* and its range extends from the winter rainfall area of Western Cape to the summer rainfall areas of Eastern Cape, KwaZulu-Natal, Mpumalanga and Northern Province (Figure 4). When fertile, the species bears ripe sporangia during most of the year in the summer rainfall areas. Since *F. crispa* is so common, it is clear why it was first described by the mid 1800's and not as late as 1900 by Stephani under the epithet, *F. zeyheri*.

Fossombronia crispa is distinguished by its entire, crisped leaves, its frequently robust size, generally purple stem, pseudoperianths with lobed, undulating mouth, reticulate or incompletely reticulate spores with low lamellae and elaters with strong spirals. Although there is some similarity in their spores, the elaters of *F. crispa* are clearly different from those of typical *F. capensis* (see Perold 1997b), which are short, have weak spirals and collapse upon drying.

It is shown in Perold (1997d) that *F. crispa* Nees, as described in the protologue, definitely has entire leaves. The spores, as was later found, are reticulate or incompletely reticulate but certainly not spinose. This species was subsequently redescribed by Stephani (1900) as *F. zeyheri* (sub *F. crispa*), and was considered by Scott & Pike (1987a) to be part of the widely distributed and later described, *F. foveolata* complex, because of similarities in spore ornamentation. By inference *F. crispa* would also be part of this complex. It was, however, described 30 years before *F. foveolata* and the specific name, *F. crispa*, would therefore have priority. In general, *F. crispa* is a larger plant than *F. foveolata* and I continue to treat them as distinct taxa, because this study is as yet confined to southern African species. Moreover, the specific epithet, *F. foveolata*, has a long history of acceptance.

The epithet, *F. crispa*, has, however, since Stephani (1900) generally been misapplied to plants with dentate

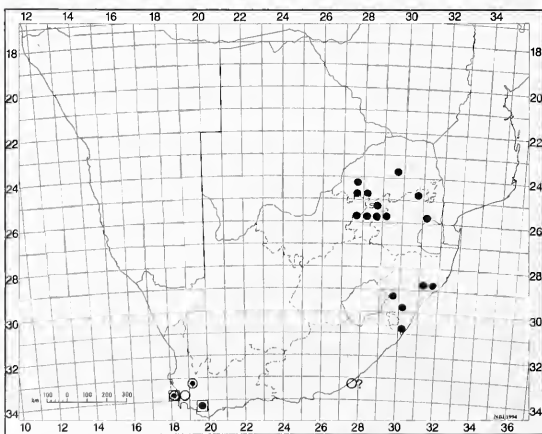


FIGURE 4.—Distribution of *F. crispa*, ●; *F. leucoxantha*, □; and *F. tumida*, ○, in southern Africa.

leaves and spinose spores (i.e. *F. leucoxantha*). For some reason Scott & Pike (1988) regarded the BM specimen, (top right corner of herbarium sheet, Perold 1997d: fig. 6C), as the type of *F. crispa*. They referred to it as 'Cape of Good Hope, leg. Zeyher, sub '*Jungermannia crispa*' Sprengel, BM (hb. Hampe. sin. num. 14/8/1825)' and annotated it on the sheet as 1:3. As I learnt from the label, this specimen is most likely an *Ecklon* collection, no. 64, and was gathered on Devil's Peak (Teufelsberg). I consider it to be a possible syntype of *F. leucoxantha* (Perold 1997d).

2. ***Fossombronia leucoxantha* Lehm.** in Linnaea 4: 368 (1829); Lehm.: 55 (1831); Sim: 36 (1926). Type: Cape of Good Hope, Table Mountain, *Ecklon* sub *Jungermannia leucoxantha* n.sp., cf. Hepat. Capens. L. 29 (S. lecto.!, fide Scott & Pike 1987b) (BM, isolecto.!, the identity of the duplicate in BM was confirmed with the aid of spores found in the glue on the sheet).

Plants in scattered loose colonies or in crowded patches, young apical leaves bright green, small, older leaves larger, soon becoming pale yellow or tinged with pink and translucent, medium-sized; shoots smaller in male plants, 6.0 mm long, 0.8 mm high, 1.5 mm wide; female plants larger, simple, up to 7.5 mm long, 2.6 mm high, 1.0 mm wide apically, increasing to 4.0 mm wide more proximally, sometimes once (Figure 6A), rarely twice furcate, terminal segments moderately divergent, only ± 1.5 mm long. *Stems* prostrate, green, outer cell layer becoming red, planoconvex in cross section, in male plants apically 175–300 µm (11 cell rows) high, 400–550 µm wide, in female plants apically (Figure 5K) ± 375 µm (11 or 12 cell rows) high, 600–750 µm wide, tapering proximally (Figure 5L), 230 µm high, 400 µm wide. *Rhizoids* purple, 12.5–22.5 µm wide, some with internal mycorrhizal hyphae and broad, flat tips. *Leaves* suberect to partly spreading, overlapping, mostly 'ruched' above, succubously inserted on stem, often decurrent, shape irregular, sometimes like a half-opened fan, shorter than wide or as long as wide or almost as long as wide above, generally narrower toward base, apex somewhat irregularly rounded to nearly truncate, margins with few to several folds (Figure 6B) and 7–24(–30) toothed projections, (more numerous on the proximal (trailing) edge), 1–3 (4) cells high, topped with a slime papilla; in male plants leaves (Figure 5A–E) smaller, 500–1300(–1675) × 425–875(–1375) µm; in female plants (Figure 5F–H) larger, 1575–2250 µm long, width above 1875–3950 µm and below 550–1500 µm. *Leaf cells* mostly thin-walled, in male plants generally somewhat smaller but otherwise not appreciably different from females, at upper margins (Figure 5I) subquadrate to rectangular across, 32.5–42.5 × 27.5–55.0 µm, at lower lateral margins long-rectangular, 50.0–87.5 × 17.5–40.0 µm, upper laminal cells 5- or 6-sided, 50.0–67.5 × 40.0–62.5 µm, middle laminal cells 75.0–112.5 × 37.5–65.0 µm; basal cells 100.0–162.5 × 37.5–50.0 µm. *Oil bodies* 14–18 per cell, tiny; chloroplasts in young apical leaves numerous, granular, round or oval, 5 µm in diameter (Figure 5J).

Dioicous. *Antheridia* dorsal on stem, usually in 2 crowded rows (Figure 6C, D), short-stalked, globose, 320–380 µm in diameter, turning yellow, each subtended by a perigonal bract (Figure 5M–O), sometimes

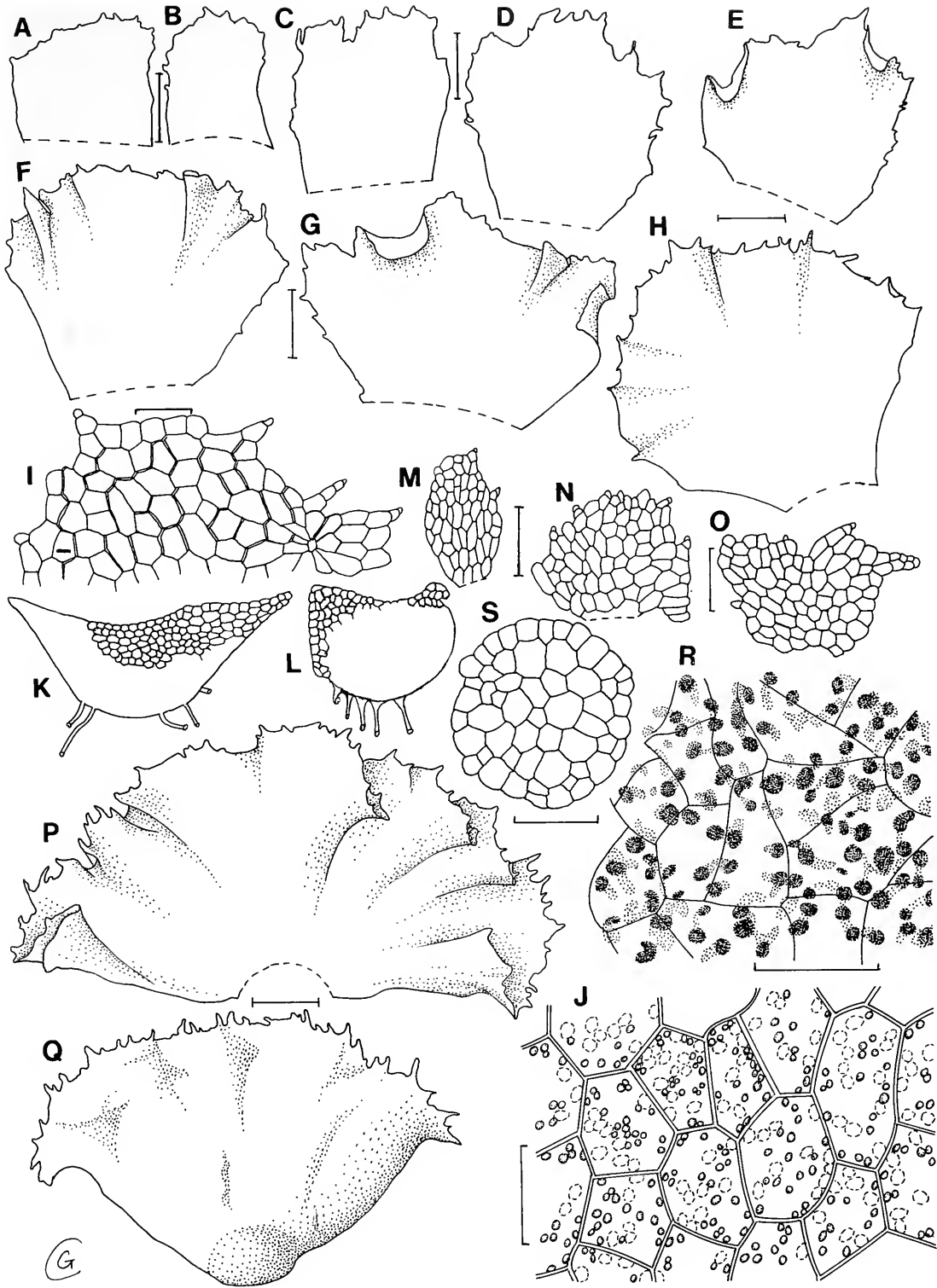


FIGURE 5.—*Fossombronía leucoxantha*. A–E, male leaves; F–H, female leaves; I, leaf margin; J, median leaf cells with oil bodies (solid lines) and chloroplasts (dotted lines); K, cross section of female stem apex; L, cross section of female stem base; M–O, bracts; P, opened pseudoperianth; Q, pseudoperianth from side; R, cells in capsule wall; S, cross section of seta. A, B, F, G, I, K, M–Q, *Oliver* 9225; C–E, H, J, L, S, *S.M. Perold* 3340; R, *S.M. Perold* 3329. Scale bars: A–H, P, Q, 500 µm; K–O, 250 µm; I, J, R, 50 µm; S, 100 µm. Artist: G. Condy.

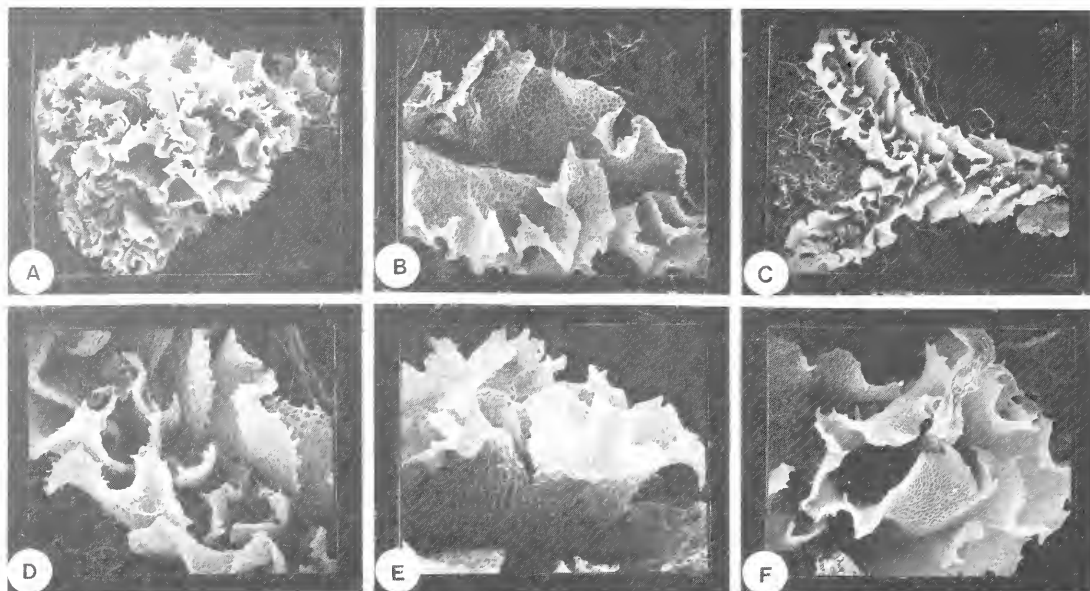


FIGURE 6.—*Fossombronina leucoxantha*. A, branched female stem; B, detail of leaves; C, branched male stem; D, detail of bracts; E, pseudoperianth from side; F, pseudoperianth from above. A–E, Oliver 9225; F, S.M. Perold 3340. A, $\times 8.3$; B, $\times 21.6$; C, $\times 8$; D, $\times 25$; E, $\times 24$; F, $\times 17$.

coloured pink, $310\text{--}450 \times 200\text{--}400\text{ }\mu\text{m}$, occasionally 2 adjacent ones joined together, margins with 3–5 papillae, cells of interior 4–6-sided, $50.0\text{--}75.0 \times 30.0\text{--}37.5\text{ }\mu\text{m}$. *Archegonia* in 1 or 2 rows along stem, hidden by leaves, sometimes 2 in close proximity becoming fertilized. *Pseudoperianth* (Figure 6E, F) campanulate, proximal to apex, as tall as leaves or projecting somewhat above them, raised on a short stalk, then widely flaring above, $1500\text{--}2250\text{ }\mu\text{m}$ long, $750\text{--}1500\text{ }\mu\text{m}$ wide at base, $2375\text{--}4375\text{ }\mu\text{m}$ wide across mouth, margin much 'ruched', with several 'folds' and up to 39 toothed processes (Figure 5P, Q), 3–7 cells or $100\text{--}325\text{ }\mu\text{m}$ long, topped by a slime papilla, $\pm 12.5 \times 15.0\text{ }\mu\text{m}$ and gradually widening below; cells comparable in shape and size to those of leaves. *Capsules* globose, $800\text{--}1050\text{ }\mu\text{m}$ in diameter, wall bistratose, cells of inner layer irregularly shaped (Figure 5R), $30.0\text{--}62.5 \times 32.0\text{--}50.0\text{ }\mu\text{m}$, each cell wall with 2 or 3 dark brown, nodular, and sometimes semi-annular thickenings. *Seta* $0.2\text{--}4.0\text{ mm}$ long, $\pm 220\text{ }\mu\text{m}$ in diameter, 7 or 8 cells across (Figure 5S). *Spores* light brown, $42.5\text{--}55.0$ in diameter, including spines projecting at margin (Figure 7D); hemispherical; distal face (Figure 7A–C) convex, with 12–15 truncate or conical spines up to $5\text{ }\mu\text{m}$ long, in irregular rows across diameter of spore, some confluent to form short ridges and mostly interconnected by small buttressing ridges that radiate from the bases of adjacent spines, often with several smallish papillae interspersed between spines and ridges; proximal face (Figure 7E) with triradiate mark distinct or lacking, flat, ornamentation variable, from numerous, rather fine papillae to coarse tubercles, often interspersed with short, irregular ridges, around spore periphery with up to 30 or occasionally more spines seen in profile or broad-on. *Elaters* yellow-brown, $130\text{--}202\text{ }\mu\text{m}$ long, $7.5\text{ }\mu\text{m}$ wide in centre, tapering to tips, $2.5\text{--}5.0\text{ }\mu\text{m}$ wide, sometimes surface sprinkled with fine papillae (Figure 7F), bispiral or trispiral.

Fossombronina leucoxantha grows on damp, rather coarse to clayey soil at various places in the Peninsula and Western Cape, i.e. Bakoven, Bot River, Cave Peak, Chapman's Peak, Constantia Slopes, Devil's Peak, Genadendal, Karweiderskraal, Kirstenbosch Gardens, Kloofnek, between Kloofnek and Round House, Lion's Head, Round House, Signal Hill, Table Mountain and Wynberg, Cape Town (Figure 4). In this rather restricted area the species is quite common. It is distinguished by its 'ruched' leaves, of which the margins, as well as the rim of the mouth of the pseudoperianth are denticulate to incised-dentate. There are a few specimens that have almost entire leaves, notably *Esterhuysen* 24885 and *Arnell* 616, that probably do not belong here in spite of having spinose spores. The spores of *F. leucoxantha* are densely spinose, but often have papillae or short ridges between the spines. This species is distinguished from *F. glenii* (Perold 1997a) which also has spinose spores, but is restricted to the summer rainfall area in Northern Province, Gauteng and Mpumalanga and its leaves are angular, and the rather small pseudoperianth is divided into deep lobes.

Fossombronina leucoxantha was described by Lehmann (1829) from an *Ecklon* collection. This *Ecklon* specimen was mixed with a tumid-leaved plant, later described by Mitten (1878) as *F. tumida* from a collection by Rev. Eaton at the Cape. Stephani's *Icones* (1985), nos. 3044 and 3045, illustrate *F. tumida*, but at the bottom right corner they bear the epithet, *F. leucoxantha*. In a note under his description of *F. leucoxantha*, Stephani (1900) referred to its leaves as 'aufgeblasen', which could only apply to *F. tumida*. Subsequently, Sim (1926) complained that Stephani 'mentions it [meaning *F. tumida*] near *F. leucoxantha*, which is not its place'.

Arnell (1963) placed *F. leucoxantha* Steph. (surely implying *sensu* Steph.) in synonymy under *F. tumida* and

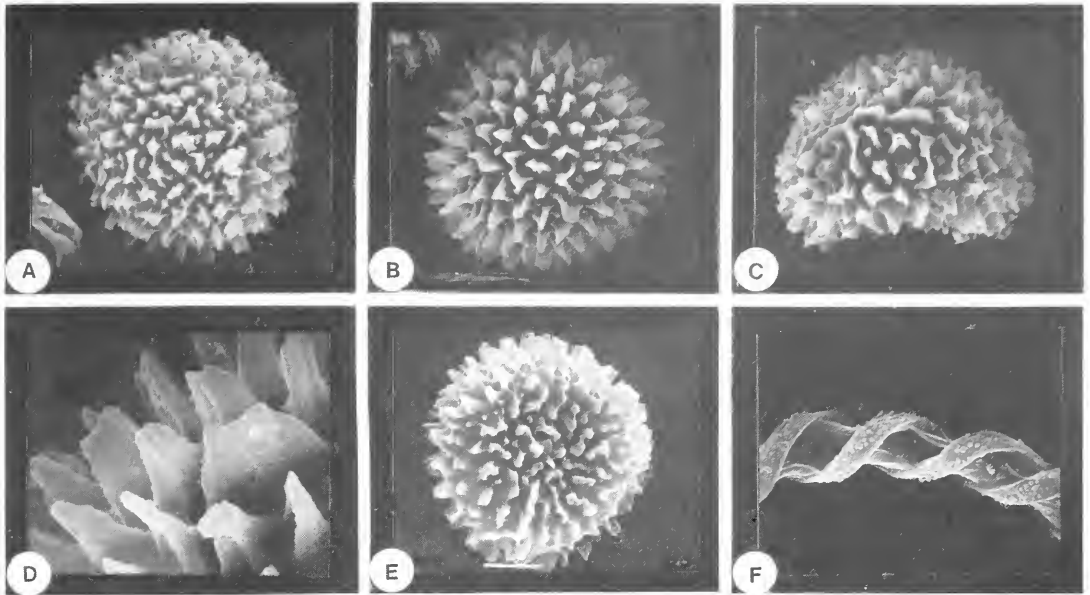


FIGURE 7.—*Fossombronina leucoxantha*. A–E, spores: A, B, distal face; C, side view of distal face; D, detail of spinous processes at margin of distal face; E, proximal face. F, detail of part of elater. A, Ecklon s.n. (W) 7693; B, D, S.M. Perold 3345; C, Ecklon s.n. (S) L. 29; E, Oliver 9225; F, S.W. Arnell 247. A, $\times 742$; B, $\times 642$; C, $\times 835$; D, $\times 2196$; E, $\times 802$; F, $\times 1477$.

made no further reference to the former in his book, although there are specimens held at BOL, PRE and S that he had identified as *F. leucoxantha*. Scott & Pike (1987b) have already drawn attention to the confusion between *F. leucoxantha* and *F. tumida*. They also state that 'Arnell's own specimens which he had identified as *F. leucoxantha* 'L. & L'. are mostly *F. spinifolia* St.'. This assumption is incorrect: they had no knowledge of the spore morphology of *F. spinifolia*, as they had overlooked a capsule with ripe spores in the type specimen. *Fossombronina spinifolia* has spores with short irregular lamellae and very few spines. It also is a small plant and has been treated in a previous paper in the current series (Perold 1997c). Scott & Pike (1988) expressed the opinion that the spores 'of what we take to be this species (i.e. *F. spinifolia*) are very similar to those of *F. crispa* '(p. 199) and 'apparently identical,' (p. 193) (see their figs 5 & 6 of spinose spores from the BM sheet, top right corner). The spores which Scott & Pike (1988: figs 27 & 28) illustrate under *F. spinifolia* belong to *F. leucoxantha*. Their spore micrographs of the lectotype of *F. leucoxantha* (Scott & Pike 1987b: figs 3 & 4) depict spines and some ridges and are marginally different from mine (see Figure 7A–E in this paper), but are nevertheless still within the acceptable range of variation in spore ornamentation that I found in the many spore micrographs that I took of this species.

Stephani (1900) recognized three southern African species with spinose spores, *F. spinifolia*, the so-called *F. crispa* and *F. leucoxantha*. He did not have the opportunity to examine spore-bearing material of *F. leucoxantha* and *F. tumida* which he confused with each other; Sim (1926) recognized two species with spinous spores, *F. crispa* with 'long papillae' and *F. leucoxantha* with 'short papillae' in which he followed Stephani; Arnell (1963) placed *F. leucoxantha* (*sensu* Steph.) in synonymy under *F. tumida*, treating *F. crispa* as the only species with spin-

ous spores; Sérgio (1985) accepted *F. crispa* as having spinose spores and *F. zeyheri* as having reticulate spores; Scott & Pike (1988) retained *F. crispa* as a species with spinose spores and thought that Arnell's earlier determinations of *F. leucoxantha* were actually *F. spinifolia*.

3. *Fossombronina tumida* Mitt. in Journal of the Linnean Society 16: 193 (1878); Sim: 35 (1926); S.W. Arnell: 80 (1963). Type: Cape of Good Hope, 'on damp ground near the pine plantation at the foot of the Lion's Head, near the beginning of the Kloof road, Cape Town', Rev. A.E. Eaton (Aug. & Sept. 1874) (NY, holo.!; W6447, iso!).

Plants in densely crowded or loosely scattered colonies, pale green, becoming white, often tinged with violet-red or with scattered small red flecks; medium-sized to quite robust; shoots simple, 5–12 mm long, 1.1–1.8 mm high, 1.0–2.5(–3.0) mm wide, or once (Figure 9A), rarely twice furcate, terminal segments closely to moderately divergent, ± 3 mm long. Stems prostrate, plano-convex in cross section, apically (Figure 8I) 300–440 μm (up to 15 cell rows) high, 530–730 μm wide, tapering proximally and toward base (Figure 8J), 420 μm high, 480 μm wide, pale green to yellowish, sometimes ventrally purple, occasionally with a lateral bud. Rhizoids purple, 12.5–20.0 μm wide, some with internal mycorrhizal threads. Leaves (Figure 8A–E) overlapping (Figure 9C), suberect, flaccid, very concave, appearing inflated, in terminal segments apices from opposite sides of stem incurved over one another (Figure 9B), obliquely inserted, proximal (trailing) edge almost mid-dorsal on stem, distal (leading) edge lateral, rounded to somewhat irregular, rarely with an appendage at proximal edge, shorter than wide, apically smaller, 675–800 \times 1425–1625 μm , covered and preceded by mostly larger, billowing, older leaves, 850–1575 \times 1450–2250 μm ; mar-

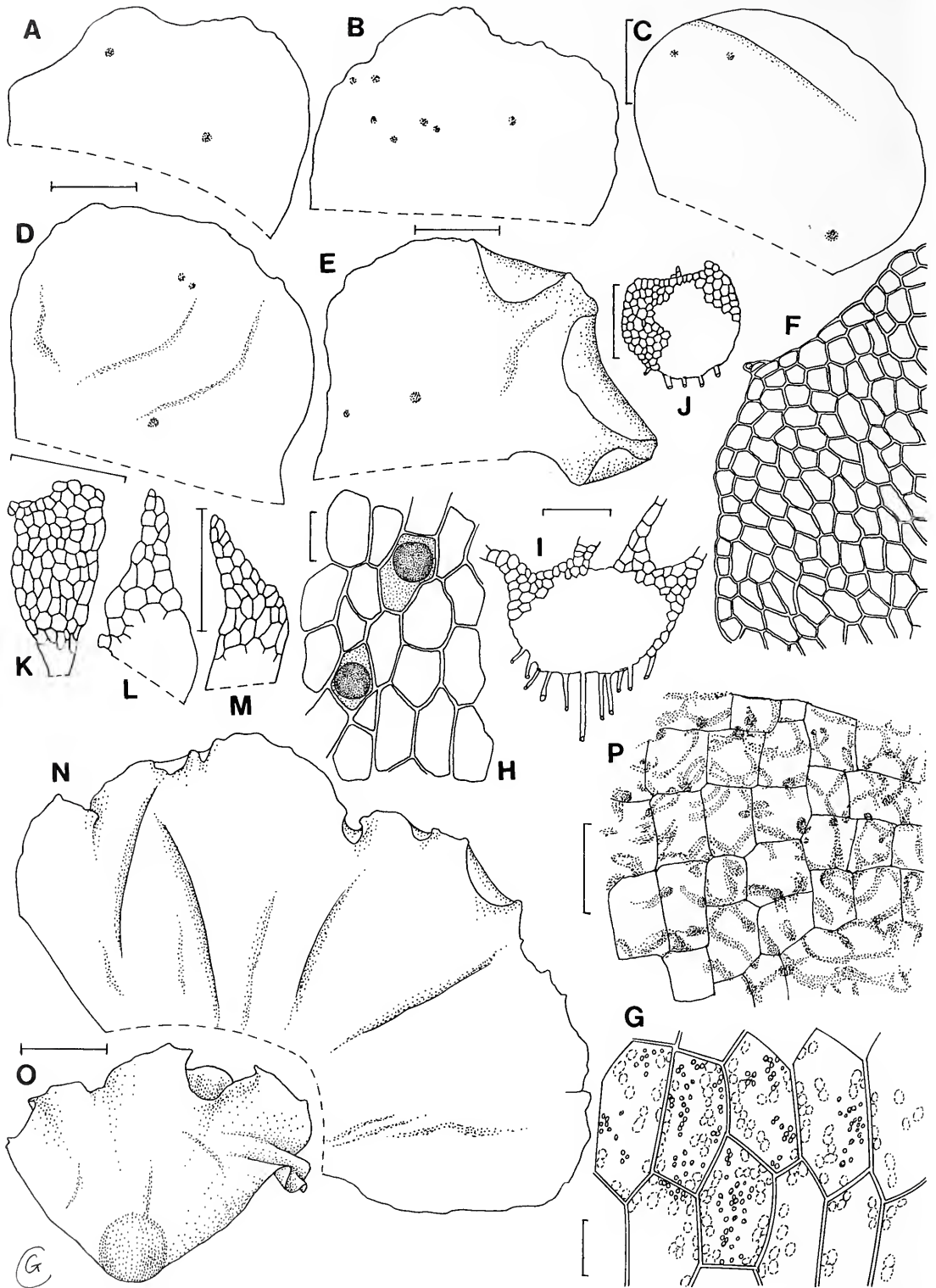


FIGURE 8.—*Fossombronina tunida*. A–E, leaves; F, detail of leaf margin; G, median leaf cells with oil bodies (solid lines) and chloroplasts (dotted lines); H, scattered red-stained leaf cells with dark round body; I, cross section of stem apex; J, cross section of stem base; K–M, bracts; N, opened pseudoperianth; O, pseudoperianth from side; P, cells in capsule wall. A–C, E, G, J, O, *Libenau-Nestlé SA 425*; D, F, I, *C. M. van Wyk 1494*; H, N, P, *Garside 6109*; K, L, M, *Garside 8335*. Scale bars: A–E, N, O, 500 µm; F–H, P, 50 µm; I–M, 250 µm. Artist: G. Condy.

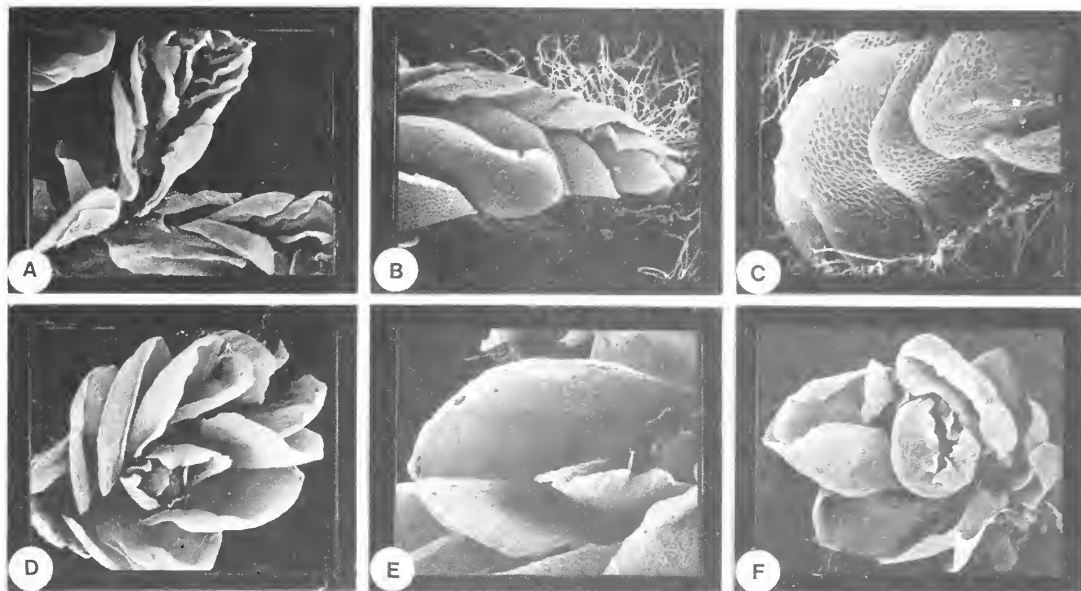


FIGURE 9.—*Fossombroncia tumida*. A, branched stem, B, apex of branch with tightly inflexed leaves seen from above, C, overlapping leaves seen from the side; D, leaves and young pseudoperianth seen from above, E, young pseudoperianth seen from side; F, pseudoperianth with mouth inflexed. A, D–F, Garside 6109; B, C, Lübenau-Nestlé SA 425. A, $\times 6.6$; B, $\times 15.6$; C, $\times 25$; D, $\times 8$; E, $\times 14$; F, $\times 9$.

gins entire, sometimes becoming eroded at upper edge, with up to 9, usually well-spaced slime papillae, $\pm 17.5 \times 17.5 \mu\text{m}$, occasionally raised on a basal cell, $\pm 10.0 \times 22.5 \mu\text{m}$. *Leaf cells* thin-walled, at upper margins (Figure 8F) subquadrate to rectangular across, $27.5\text{--}50.0 \times 37.5\text{--}55.0 \mu\text{m}$, at lower lateral margins long-rectangular, $87.5\text{--}112.5 \times 12.5\text{--}20.0 \mu\text{m}$, upper laminal cells 5- or 6-sided, $55.0\text{--}75.0 \times 45.0\text{--}50.0 \mu\text{m}$, middle laminal cells $87.5\text{--}100.0 \times 50.0\text{--}62.5 \mu\text{m}$, basal cells $80.0\text{--}87.5 \times 47.5\text{--}52.5 \mu\text{m}$; scattered throughout some leaves, single cells often stained red and containing a dark, round, internally granular body, rarely 2, up to $50 \mu\text{m}$ in diameter (Figure 8H). *Oil bodies* rounded, (Figure 8G) oval or irregular in shape, minute; chloroplasts mostly lost in the material examined or clumped together at cell margins.

Dioicous. *Male plants* seemingly scarce, generally longer and narrower than females with pseudoperianths, but gametangia hidden by inflexed leaves. *Antheridia* dorsal on stem, between leaves, globose, short-stalked, $\pm 150 \mu\text{m}$ in diameter, each one subtended by a small, \pm triangular perigonal bract (Figure 8K–M), $250\text{--}400 \times 120\text{--}170 \mu\text{m}$, cells in interior 5- or 6-sided, $37.5\text{--}45.0 \times 25.0\text{--}27.5 \mu\text{m}$. *Archegonia* naked, in an interrupted, irregular row along stem. *Pseudoperianths* (Figure 8N, O) on female plants which are simple, inflated, subglobose 'balls' (Figure 9D), $\pm 5 \times 3 \text{ mm}$, with leaves up to $2500 \times 3375 \mu\text{m}$, mostly single, rarely two in a row, almost sessile, turbinate, rather shorter than or as tall as leaves, $1375 \mu\text{m}$ long, basally $\pm 750 \mu\text{m}$ wide, then quickly flaring above (Figure 9E), $\pm 2250 \mu\text{m}$ wide across mouth, occasionally inflexed (Figure 9F), irregularly and shallowly lobed, sometimes with projecting longitudinal 'seam' on inside; cells not appreciably different in shape and size from those of leaves. *Capsules* globose, $\pm 1000 \mu\text{m}$ in diameter, wall bistratose, cells of inner layer (Figure 8P) irregularly shaped, $22.5\text{--}60.0 \times 22.5\text{--}25.0 \mu\text{m}$, each cell wall with ± 3 yellow-brown, nodular and

semi-annular thickenings or sometimes entire wall thickened. *Seta* $\pm 400 \mu\text{m}$ long, $250 \mu\text{m}$ in diameter. *Spores* brown, $45\text{--}55 \mu\text{m}$ in diameter, including marginal lamellae; hemispherical; distal face (Figure 10A, B) convex, with rather wavy, \pm parallel lamellae, (Figure 10C), $5.0\text{--}7.5 \mu\text{m}$ high, projecting at periphery (Figure 10D), over polar area anastomosing to form few to many (± 36) areolae, $2.5\text{--}5.0 \mu\text{m}$ wide; proximal face (Figure 10E) lacking triradiate mark, flat, covered with irregularly curving and branching ridges, (sometimes markedly raised), and a few coarse papillae, ± 28 'spines' projecting around spore periphery, not connected by perispore. *Elaters* (Figure 10F) yellow-brown, $152.5\text{--}200.0 \mu\text{m}$ long, $10 \mu\text{m}$ wide in centre, tapering to looped tips, $5 \mu\text{m}$ wide, smooth, bispiral or partly trispiral.

Fossombroncia tumida grows on damp, rather sandy soil at Lion's Head, the Round House, Kloofnek, Stellenbosch Flats and at Roman River, south of Wolseley (Figure 4). A specimen, *Wager 39* (CH 3703) is said to be from East London, but this locality could be wrong. Sim (1926) observed that it is found in S.W. (meaning Western Cape) localities, 'but not seen eastward'. This species is by no means common.

Fossombroncia tumida is distinguished by its inflated or tumid appearance and very concave leaves, with small, scattered red flecks containing round bodies. The spores are generally reticulate over the distal pole, and the outer areolar walls break down into lamellae which continue to the margin.

Scott & Pike (1987b) regard *F. tumida* as very similar vegetatively to *F. intestinalis* Tayl. from Australia and Tasmania, but 'with experience, however, they can be separated. The former is larger, with flaccid leaves often tinged with purple-brown and with entire instead of slightly denticulate leaves. The spores are quite distinct'.

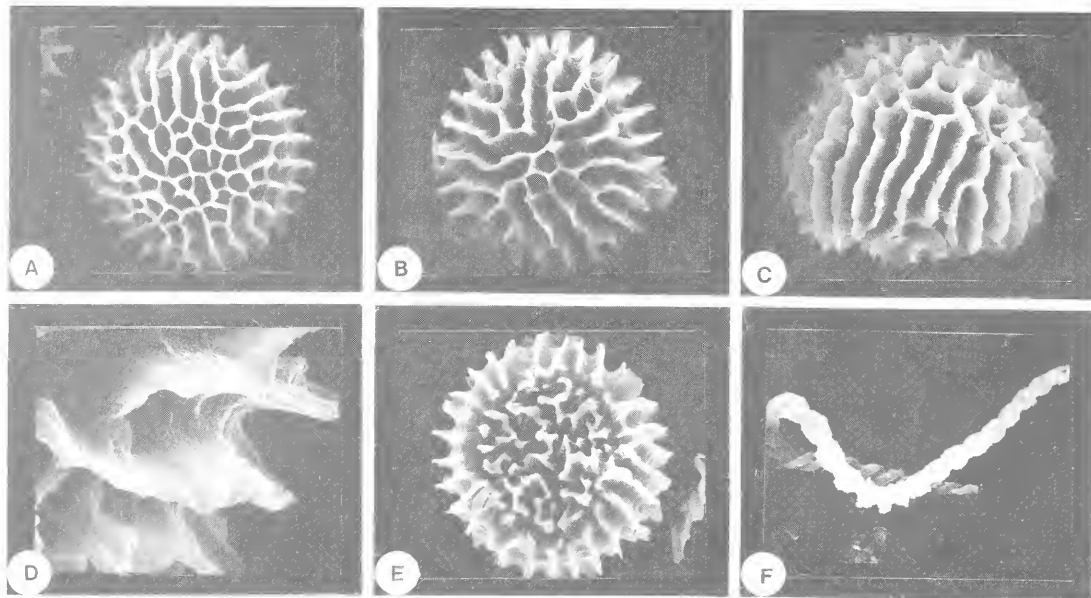


FIGURE 10.—*Fossombronina tumida*. A–E, spores. A, B, distal face, C, side view of distal face, D, detail of lamellae at margin of distal face, E, proximal face. F, elater. A, E, *Garside* 6109; B, D, *Garside* 8335; C, F, *Duthie* CH1580. A, $\times 659$; B, $\times 562$; C, $\times 642$; D, $\times 2356$; E, $\times 672$; F, $\times 356$.

Scott (1985) claims that *F. intestinalis* also occurs in southern Africa, but does not cite a particular specimen. I have not found it so far. The confusion between *F. tumida* and *F. leucoxantha* is discussed above under the latter species.

SPECIMENS EXAMINED

With one exception, only fertile specimens are included; held at PRE, unless otherwise indicated.

S.W. Arnell 39, 46, 116 (2) BOL, 149 (2) BOL, 199 (2) BOL, 247 (2), 266 (2) BOL; 274 (2), 275 (2) BOL, 282 (2), 384 (2) BOL, 626 (2) BOL, 941 (2) BOL, 1118 (2) BOL, 1205 (2) S, 2161, 2181 (1) BOL, 2184, 2201 (1).

Bottomley CH 3567 (1). Breutel herb. no. 024665 (2) G.

Duthie CH 1580 (3).

Eaton (3) NY (holo.), herb. no. 6447 (3) W (iso.). Ecklon ex herb. Dr Winter, herb. no. 024660 (1) G; L. 29 (lecto.) (2) S; (isolecto.) (2) E; herb. no. 7693 (2) W; 64 (?syntype) (2) BM; herb. no. 7692 (3) W.

Garside 6109 (3) BOL, 6218 (2) BOL, 6463 (2) BOL, 6488 (2) BOL, 6498a (2) BOL, 6498 (3) BOL, 6703 (2) BOL, 6707 (2) BOL, 6722 (2) BOL; 8335 (3) PRE. *Garside* & Arnell 115 (2). Glen 2258, 2261a (1).

Lübenau-Nestlé SA3 (2), 14 (1), SA425 (3) private herb.

Oliver, E.G.H. 9225 (2).

S.M. Perold 65, 2704, 2457, 2887 (sterile, det. E.W. Jones as *F. zeyheri*), 3280 pp., 3317 (1); 3329; 3331, 3332, 3337, 3340, 3341, 3344, 3345, 3355 (2); 3444 (1). S.M. Perold & Koekemoer 3282, 3606, 3615 (1). S.M. Perold & Van Rooy 3558, 3567 (1). Pillans 4241 (1) BOL.

Reichenbach herb. no. 354138 (1) W. Reinecke CH182 (1). Reimann herb. no. 5578 (3) W.

Schelpel 5160 (1) BOL. Sim CH1587, CH1616, CH1633, CH1634, CH1645, CH1648 (1). Sprengel L. 32, no. 244 (1) S. S. Strauss, 134a, 209, CH13664 (1).

C.M. Van Wyk, 1494 (3). J. Victor, 1379, 1380 (1).

H.A. Wager, 27, 28 (1); 39 (3). V.A. Wager, 112 (1). Wilms 2538 (3) W. Zeyher herbarium sheet, top row: left corner, middle, lower row: left BM, ex herb. Moricand no. 481 herb. no. 024661 (G), Flora Cap. no. 482 S, herb. no. 024663 G, ex herb. Rabenhorst herb. no. 024669 G, ex

herb. (?)ope herb. no. 024670 G, Flora Cap. no. 482 G herb. no. 024676 G (1).

Without collector's name

Cap (3 written on packet in pencil) STR, lecto., ex herb. Lehmann S, ex herb. Karl Müller S, Gottsche dedit. herb. no. 024659 G, ex herb. de Candolle ex herb. Mull. herb. no. 024662 G, Jack dedit. herb. no. 024664 (1) G.

ACKNOWLEDGEMENTS

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Taxonomic notes on the Geastraceae, Tulostomataceae, Nidulariaceae and Sphaerobolaceae (Gasteromycetes) *sensu* Bottomley, in southern Africa

J.C. COETZEE*, A. EICKER** and A.E. VAN WYK**

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ABSTRACT

Bottomley's (1948) *Gasteromycetes of South Africa* is still widely used for identification purposes. However, as a result of developments since 1948, the work has become outdated in many respects. Entries in the Geastreae (Lycoperdaceae), Tulostomataceae, Nidulariaceae and Sphaerobolaceae *sensu* Bottomley (1948) that require updating are listed and briefly commented on.

INTRODUCTION

Although Bottomley's (1948) *Gasteromycetes of South Africa* was, in her own words, '... not in any sense a critical revision...' but '... merely an assembling of the known records of these fungi in Southern Africa', it still remains the standard source of reference with regard to the identification and classification of the Gasteromycetes of the region. However, errors in the original work, changes to the International Code of Botanical Nomenclature (ICBN) and particularly, considerable changes in Gasteromycete systematics since 1948, contributed to an unfortunate situation in which current users of Bottomley (1948) are at considerable risk of ending up with incorrect identifications or outdated names. In the families considered in this paper more than 70% of the entries in Bottomley (1948) are affected to a greater or lesser degree.

Since a comprehensive revision of the southern African Gasteromycetes is still some years in the offing, there is a need for an interim guide listing those entries in Bottomley (1948) which may lead to the inaccurate identification and classification of specimens. In this first instalment, the Geastreae (Lycoperdaceae), Tulostomataceae, Nidulariaceae and Sphaerobolaceae *sensu* Bottomley (1948) are considered. It is emphasized that this paper is primarily a reflection of views and ideas expressed in the literature since 1948, and that it does not claim to be a critical re-appraisal of any of the taxa concerned. The principle objective is to provide an interim aid towards the more effective use of Bottomley (1948).

The order of arrangement of the taxa listed below follows Bottomley (1948), and the taxon name and author citation heading each entry have been taken, unchanged, from that publication. The number in brackets following each heading refers to the relevant page number in Bottomley (1948). Entries in Bottomley (1948) which, to our present knowledge, do not require comment, are not included in the list. This also applies to names in which

the only 'error' to be corrected is the outdated use of the capital letter in epithets derived from personal names (e.g. *Batarrea Stevenii* instead of *Batarrea stevenii*). Suggested taxon names are supplied in bold. Unless stated otherwise, references to ICBN articles and recommendations pertain to the Tokyo Code (Greuter *et al.* 1994). Author citations are abbreviated according to Brummitt & Powell (1992).

ANNOTATED LIST OF TAXA

1. Geastreae (586)

The tribe Geastreae *sensu* Bottomley (1948) has subsequently been treated at the family level (**Geastraceae** Corda; order Lycoperdales) by most eminent gasteromycete taxonomists (Zeller 1949; Eckblad 1955; Kreisel 1962; Demoulin 1968; Ponce de León 1968; Dring 1973; Calonge & Demoulin 1975; Demoulin & Dring 1975; Demoulin & Marriott 1981; Sunhede 1989; Mornand 1993). Exceptions include Dörfelt and co-workers who place these organisms in the order Geastrales (Dörfelt & Müller-Urli 1984; Dörfelt & Bumzaa 1986; Dörfelt & Heklau 1987).

1.1 Geastrum Persoon (586)

In accordance with the changes to the ICBN enacted in 1981 (Korf 1983), the appropriate author citation, indicating the sanctioned status of this name, is **Geastrum Pers.: Pers.**

De Villiers (1994) has recently completed a revision of the genus *Geastrum* in South Africa, providing an updated key to their identification.

1.1.1 *Geastrum pectinatum* Persoon (588)

According to Korf (1983) the author citation as used in Bottomley (1948) is acceptable in non-taxonomic works only. In taxonomic treatments authors are strongly advised to use the more informative ***Geastrum pectinatum* Pers.: Pers.**

* Department of Biological Sciences, Peninsula Technikon, P.O. Box 1906, 7535 Bellville, Cape Town.

** Department of Botany, University of Pretoria, 0002 Pretoria.

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1.1.2 *Geastrum bryantii* Berkeley (589)

Ponce de León (1968) dismissed both *Geastrum bryantii* Berk. and *Geastrum striatum* DC. as mere variations of *Geastrum pectinatum* Pers.: Pers. His view, however, has not been widely accepted and subsequent authors (Dörfelt & Heklau 1987; Sunhede 1989; Mornand 1993) treat *G. striatum* and *G. pectinatum* as separate species. According to Dörfelt & Heklau (1987), Sunhede (1989) and De Villiers (1994), however, *G. bryantii* Berk. is a synonym of ***Geastrum striatum* DC.**

1.1.3 *Geastrum nanum* Persoon (589)

Ponce de León's (1968) merging of *Geastrum nanum* Pers. with *G. pectinatum* does not seem to have found widespread acceptance and recent authors have retained the two as separate species (Dörfelt & Heklau 1987; Sunhede 1989; Mornand 1993). As pointed out by Dörfelt & Heklau (1987) and Sunhede (1989), however, *G. nanum* Pers. is an illegitimate name to be replaced with ***Geastrum schmidelii* Vittad.**

1.1.4 *Geastrum ambiguum* Montagne (591)

Bottomley (1948) and Ponce de León (1968) regard *Geastrum drummondii* Berk. and *Geastrum ambiguum* Mont. as the same species. Dring (1964) and Sunhede (1989), however, both expressed the view that more material should be examined before such a conclusion is drawn. According to Sunhede (1989) both of these species are very similar to *Geastrum campestre* Morgan. Demoulin & Dring (1975), on the other hand, state that *G. ambiguum* in Bottomley (1948) is the same as the *G. drummondii* of Dring (1964) and Dring & Rayner (1967), and that it differs from the type specimens of *G. ambiguum* and *G. drummondii*. They adopt the name *Geastrum schweinfurthii* Henn. for this fungus. Bottomley (1948) and Ponce de León (1968) regarded *G. schweinfurthii* as conspecific with *G. ambiguum*. De Villiers (1994) does not follow Demoulin & Dring (1975) in recognizing *G. schweinfurthii* as a separate species, stating that '...there is not (sic) doubt that the southern African collections of *G. ambiguum* have been correctly identified by Bottomley ...'. The last word on the identity of this fungus has probably not been spoken.

1.1.5 *Geastrum quadrifidum* Persoon (591)

According to Korf (1983) the author citation as used in Bottomley (1948) is acceptable in non-taxonomic works only. In taxonomic treatments authors are strongly advised to use the more informative ***Geastrum quadrifidum* Pers.: Pers.**

1.1.6 *Geastrum dissimile* n. sp. (592)

According to Dissing & Lange (1962), Dring & Rayner (1967), Sunhede (1989), De Villiers (1994) and De Villiers & Eicker (1996), this is a good species and not a synonym of *Geastrum minimum* Schwein. as reported by Ponce de León (1968). The name, correctly cited, therefore, is ***Geastrum dissimile* Bottomley.**

1.1.7 *Geastrum limbatum* Fries (594)

Ponce de León (1968), Calonge & Demoulin (1975) and Sunhede (1989) all regard *Geastrum limbatum* Fr. as a synonym of ***Geastrum coronatum* Pers.: Pers.**

According to Sunhede (1989), *Geastrum limbatum sensu* Coker & Couch is the same fungus as the one described by Lloyd as *Geaster limbatus*, cited by Bottomley (1948) as a good description of *G. limbatum* Fr. *G. limbatum sensu* Coker & Couch, however, is generally accepted to be a synonym of *Geastrum smardae* V.J. Staněk (Ponce de León 1968; Sunhede 1989).

A comparison of the descriptions in Bottomley (1948) and Sunhede (1989) indicates that Bottomley's fungus might be *G. coronatum* rather than *G. smardae*. This view has recently been confirmed by De Villiers (1994).

1.1.8 *Geastrum triplex* Junghuhn (595)

Ponce de León (1968), Smith & Ponce de León (1982) and, according to Sunhede (1989), several other authors have regarded *Geastrum indicum* (Klotzsch) Rauschert as the legitimate name for *Geastrum triplex* Jungh. Other authors such as Sunhede (1977), Dörfelt & Müller-Uri (1984), Dörfelt & Heklau (1987) and Sunhede (1989), however, all argue that *G. indicum* should be rejected as a *nomen dubium* and that *G. triplex* should be retained as the correct name for this species, as has also been done by Mornand (1993).

Geastrum lageniforme Vittad. and *Geastrum morganii* Lloyd, cited by Bottomley as synonyms of *G. triplex* are, however, accepted as good species by Sunhede (1989). De Villiers (1994) also accepts a distinction between *G. lageniforme* and *G. triplex*.

According to Dörfelt & Müller-Uri (1984), *Geastrum capense* Thüm., also cited as a synonym of *G. triplex* by Bottomley (1948), is a later synonym of *Geastrum saccatum* Fr. However, De Villiers (1994) regards *G. capense* as a synonym of *G. lageniforme*.

1.1.9 *Geastrum mirabile* Montagne (598)

It is generally accepted (Zeller 1948; Dring & Rayner 1967; Ponce de León 1968; Demoulin & Dring 1975; De Villiers 1994) that *Geastrum mirabile* Mont. is a synonym of ***Geastrum schweinitzii* (Berk. & M.A. Curtis) Zeller.**

1.1.10 *Geastrum velutinum* Morgan (599)

Ponce de León (1968) regarded *Geastrum velutinum* Morgan as synonym of the earlier described *Geaster javanicus* Lév., and created the new combination *Geastrum javanicum* (Lév.) P. Ponce de León. As explained in Demoulin (1984), however, *Geaster* is merely an orthographic variant of *Geastrum*, which makes Ponce de León's combination superfluous. According to Dring & Rayner (1967), as well as Sunhede (1989), a thorough revision of *G. velutinum* and related taxa is desirable. De Villiers (1994) accepts *G. velutinum* as the correct name,

but if this fungus is indeed conspecific with *G. javanicum*, the correct spelling and citation will be *Geastrum javanicum* Lév.

This fungus must have confused Bottomley (1948) as well, since, while she regards it as a good species on p. 599, she also lists the name *Geastrum velutinum* as a synonym under *G. saccatum* on p. 597.

1.1.11 *Geastrum arenarium* Lloyd (600)

Ponce de León (1968) considers this to be a synonym of *Geastrum minimum* Schwein. Despite Sunhede's (1989) acknowledgment of the similarity between *Geastrum arenarium* Lloyd and *G. minimum*, he prefers to retain them as separate species (Sunhede 1986, 1989), a view endorsed by De Villiers (1994). According to the latter author, Bottomley (1948) correctly referred her material to *G. arenarium*.

1.1.12 *Geastrum mammosum* Chevallier (600)

Ponce de León (1968) treats this fungus as *Geastrum recolligens* (Sowerby) Desv. which, according to Sunhede (1989), should be *Geastrum recolligens* (With.) Desv. According to Dörfelt & Bumzaa (1986), however, both *Geastrum mammosum* Chevall. and *G. recolligens* [the latter as *G. recolligens* (Woodw.) Desv.] should be treated as synonyms of *Geastrum corollinum* (Batsch) Hollós. Sunhede (1989) gives a detailed explanation for this. Mornand (1993) also accepts that the correct name for both *G. mammosum* and *G. recolligens* should be ***Geastrum corollinum* (Batsch) Hollós**.

1.1.13 *Geastrum fornicatum* (Hudson) Fries (601)

Ponce de León (1968) regards this as a synonym of *Geastrum quadrifidum* Pers.: Pers., but Sunhede (1989), followed by De Villiers (1994), accepts *Geastrum fornicatum* and *G. quadrifidum* as separate species. Sunhede (1989) also explains why the correct author citation for *G. fornicatum* should be ***Geastrum fornicatum* (Huds.) Hook**.

1.1.14 *Geastrum floriforme* Vittadini (602)

The combination *Geastrum floriforme* (Vittad.) G. Cunn. as cited in Ponce de León (1968) is superfluous and the name used in Bottomley (1948) is correct. *Geastrum hungaricum* Hollós, cited by Bottomley (1948) as well as Ponce de León (1968) as a synonym of *G. floriforme*, is, however, considered to be a good species by several authors, including Dörfelt & Bumzaa (1986) and Sunhede (1989).

1.1.15 *Geastrum hygrometricum* Persoon (603)

The transfer of this fungus to the genus *Astraeus* Morgan and its placement in the family ***Astraeaceae* V.J.Staněk** (order ***Sclerodermatales***) seems to be generally accepted (Dring 1973; Calonge & Demoulin 1975; Demoulin & Marriott 1981; Sunhede 1989; Mornand 1993). The correct name and author citation are ***Astraeus hygrometricus* (Pers.: Pers.) Morgan**.

1.1.16 *Geaster* MacOwani Kalchbr. (604)

Geaster is an orthographic variant of *Geastrum* (Demoulin 1984). According to ICBN article 60.11 and recommendation 60C.1.(b), the orthography of the epithet also needs to be corrected to ***Geastrum macowanii* Kalchbr.**

Ponce de León (1968) regards this fungus, listed in Bottomley (1948) as a 'Doubtful Species', as conspecific with *G. quadrifidum* Pers.: Pers. According to Dring & Rayner (1975), however, the true identity of *G. macowanii* remains unknown.

1.2 *Myriostoma coliforme* (Dickson ex Persoon) Corda (605)

The author citation is incorrect, according to Sunhede (1989) and Mornand (1993). The correct citation should be ***Myriostoma coliforme* (With.: Pers.) Corda**.

1.3 *Geasteropsis* Conrathi Hollós (606)

According to Sunhede (1989) and article 60.11 of the ICBN, the correct orthography should be ***Geasteropsis conrathii* Hollós**.

Long (1945) placed this fungus in the genus *Trichaster* Czer. as *Trichaster conrathii* (Hollós) Long, while Ponce de León (1968) created the new combination *Geastrum conrathii* (Hollós) P.Ponce de León. In his authoritative revision of the Geastraceae, however, Sunhede (1989) is absolutely convinced that this fungus has no place in any of the above two genera and that it should be retained in the genus *Geasteropsis* Hollós. Sunhede (1989) warns, however, that his inclusion of *Geasteropsis* in the Geastraceae, as accepted also by De Villiers (1994), is tentative, pending further studies.

2. Tulostomataceae (607)

Bottomley (1948) places this family in the order Lycoperdales but it is now widely recognized (Dring 1973; Calonge & Demoulin 1975; Demoulin & Dring 1975; Demoulin & Marriott 1981; Moreno *et al.* 1992b; Mornand 1993) that it is more appropriately placed in the order ***Tulostomatales*** erected by Demoulin (1968). Bottomley provides no author citation for this family, which, according to David (1993), should be cited as ***Tulostomataceae* E.Fisch.**

In her key to the genera of the Tulostomataceae, Bottomley (1948) included the genus ***Schizostoma* Ehrenb. ex Lév. emend. Lloyd**, although it had not yet been recorded from southern Africa at the time. ***Schizostoma laceratum* (Fr.) Lév.** has, however, been recorded since then (Talbot 1958) and appears to be fairly common.

2.1 *Tulostoma* Persoon (608)

The appropriate author citation, indicating the sanctioned status of this name, is ***Tulostoma* Pers.: Pers.**

From Wright (1987) it is evident that serious shortcomings exist in Bottomley's descriptions of the southern

African *Tulostoma* species and that numerous specimens cited in Bottomley (1948) have been incorrectly identified. A taxonomic reassessment of the *Tulostoma* specimens at PREM should therefore be a worthwhile exercise.

2.1.1 *Tulostoma album* Masee (610)

Wright (1987) regards this as a doubtful species, but accepts *Tulostoma macalpinianum* Lloyd, which Bottomley (1948) cites as a synonym of *Tulostoma album* Masee, as a validly published species. As far as could be ascertained, *T. macalpinianum* has not been recorded in southern Africa yet. The specimen listed by Bottomley (1948) as *T. album* (PREM 28528) is, however, *Tulostoma lesliei* Van der Byl (Wright 1987).

2.1.2 *Tulostoma purpusii* Henn. (611)

According to Wright (1987), PREM 11690, listed in Bottomley (1948) as *Tulostoma purpusii* Henn., is in fact *Tulostoma adhaerens* Lloyd. The identity of the rest of the material cited in Bottomley (1948) requires verification.

2.1.3 *Tulostoma albicans* White (611)

This name is to be cited as *Tulostoma albicans* V.S.White. Wright (1987), however, regards *T. albicans* as '...an ill-defined species, easy to mistake for others...', and excludes Africa from its distributional range. PREM 8764, listed in Bottomley (1948) as *T. albicans*, has been described as a new species under the name *Tulostoma exasperatosporum* J.E.Wright (Wright 1983), while PREM 28638 is *Tulostoma involucreatum* Long (Wright 1987).

2.1.4 *Tulostoma bonianum* Patouillard (612)

According to Wright (1987) *Tulostoma bonianum* Pat. is a synonym of *Tulostoma pusillum* Berk.

However, with two exceptions, Wright (1987) referred all of the specimens cited under *T. bonianum* in Bottomley (1948) (PREM 1344; 1969; 20378 & 30617), to *Tulostoma verrucosum* Morgan, which, in turn, is a synonym of *Tulostoma squamosum* (J.F.Gmel.: Pers.) Pers. (Moreno et al. 1992a). Wright (1987) regards *T. pusillum* as a fungus of tropical rain forests and does not include southern Africa in its distributional range. In the light of this, the status of *T. pusillum* in southern Africa requires verification.

2.1.5 *Tulostoma brumale* Persoon (613)

In accordance with the changes to the ICBN enacted in 1981 (Korf 1983), the appropriate author citation, indicating the sanctioned status of this name, should be *Tulostoma brumale* Pers.: Pers.

According to Wright (1987), *T. brumale* is a typical European species not occurring in southern Africa. He diagnosed PREM 20946 & 31371, cited as *T. brumale* in Bottomley (1948), as *Tulostoma rufum* Lloyd and

Tulostoma nanum (Pat.) J.E.Wright respectively. In the light of this the identity of the other specimens cited as *T. brumale* in Bottomley (1948) is suspect and requires verification.

2.1.6 *Tulostoma squamosum* (Gmelin) Persoon (613)

Cf. *T. bonianum* above.

According to Korf's (1983) interpretation of the changes to the ICBN that were enacted in 1981, the authorship of this name would be more appropriately cited as *Tulostoma squamosum* (J.F.Gmel.: Pers.) Pers.

2.1.7 *Tulostoma cyclophorum* Lloyd (615)

According to Wright (1987) the specimens cited by Bottomley as Lloyd Myc. Coll. 28934, 28958 are in fact *Tulostoma purpusii* Henn. The identity of the rest of the material cited in Bottomley (1948) requires verification.

2.1.8 *Tulostoma obesum* Cooke et Ellis (616)

According to Wright (1987) this is merely a variety of *Tulostoma volvulatum* I.G.Borshch., namely *Tulostoma volvulatum* var. *obesum* (Cooke & Ellis) J.E.Wright.

Although the closely related *Tulostoma volvulatum* var. *elatum* Har. & Pat. has been reported from Namibia, Africa is not included in the distributional range of *T. volvulatum* var. *obesum* (Wright 1987). Bottomley (1948) mentions a single collection of this fungus from southern Africa, but hastens to add that no material had been available for examination. Unless Bottomley's (1948) record can be verified, the status of this fungus in southern Africa should be regarded as doubtful.

2.1.9 *Tulostoma* MacOwani Bresadola (617)

Orthographic error. According to ICBN article 60.11 and recommendation 60C.1.(b), the spelling of the epithet should be corrected. The correct spelling and author citation for this name, first published in Petri (1904), therefore is *Tulostoma macowanii* Bres. ex Petri.

2.1.10 *Tulostoma australianum* Lloyd (617)

According to Wright (1987), PREM 27501 is not *Tulostoma australianum* Lloyd as stated in Bottomley (1948), but might be *Tulostoma vulgare* Long & S.Ahmad.

2.1.11 *Tulostoma adherens* Lloyd (618)

Orthographic error. The correct spelling (Lloyd 1923), used also by Wright (1987), is *Tulostoma adhaerens* Lloyd.

Although *T. adhaerens* does occur in South Africa (PREM 11690; 41432), the specimen cited in Bottomley (1948) under this name is *Tulostoma caespitosum* Trab. ex Sacc. (Wright 1987).

2.1.12 *Tulostoma angolense* Welwitsch et Currey (618)

According to Bottomley (1948), who lists this as a doubtful species, Welwitsch & Currey (1870) remarked that *Tulostoma angolense* Welw. & Curr. is possibly not distinct from *Chlamydopus meyenianus* (Klotzsch) Lloyd. This is unlikely, however, considering its smooth spores (Wright 1987). Wright (1987) accepts this as a good species, although he classifies it as 'critical', but also mentions the possibility that it might well be *Tulostoma volvulatum* var. *elatum* Har. & Pat.

2.2 *Batarrea Persoon* (619)

As discussed in Coetzee & Eicker (1992) this name has been spelled in various ways. Bottomley (1948) used Persoon's original spelling which lends itself to correction as provided for by article 60 of the ICBN. In a number of recent works, *Battarraea* has been the preferred form of spelling (Rauschert 1986; Wright 1987; Mornand 1993 and several other authors cited in Martin & Llimona 1994). Another school of thought, however, strongly opposes this (Martin & Llimona 1994), recognizing *Battarraea* as the correct spelling. Until this matter is resolved, we prefer to use the original spelling of this name, to be cited as **Batarrea Pers.: Pers.**

2.2.1 *Batarrea phalloides* (Dickson) Persoon (619)

According to Korf's (1983) interpretation of the changes to the ICBN enacted in 1981, the authorship of this name would be more appropriately cited as **Batarrea phalloides** (Dicks.: Pers.) Pers.

2.2.2 *Batarrea Diqueti* Patouillard et Hariot (621)

The transfer of this fungus to the genus *Battarreoides* Herrera (Heim & Herrera 1961) has been widely accepted (Dring 1973; Hawksworth *et al.* 1983; Miller & Miller 1988; Coetzee & Eicker 1994; Moreno *et al.* 1995). The correct name and author citation is **Battarreoides diquetii** (Pat. & Har.) R.Heim & T.Herrera.

2.3 *Phellorina Berkeley* (622)

Orthographic error. According to Farr *et al.* (1979) *Phellorina* is an orthographic variant, the correct spelling being **Phellorinia Berk.**

2.3.1 *Phellorina inquinans Berkeley* (623)

According to the description in Bottomley (1948) this is the 'scaly' form of *Phellorinia herculeana* (Pall.: Pers.) Kreisel, which, according to Dring (1964) and Dring & Rayner (1967), is **Phellorinia herculeana** (Pall.: Pers.) Kreisel subsp. **herculeana**.

2.3.2 *Phellorina strobilina Kalchbrenner* (624)

According to the description in Bottomley (1948) this is the 'warty' form of *Phellorinia herculeana* (Pall.: Pers.) Kreisel, which, according to Dring (1964) and Dring & Rayner (1967), is **Phellorinia herculeana** subsp. **strobilina** (Kalchbr.) D.M.Dring.

2.4 *Dictyocephalos Underwood* (626)

White (1901) attributed the name *Dictyocephalos* to Underwood. It is, however, not easy to determine from the original publication whether this should be treated as an 'in' or 'ex' case as discussed in ICBN article 46 (Greuter *et al.* 1994). We therefore accept the citation suggested in Greuter *et al.* (1993), namely **Dictyocephalos Underwood ex V.S.White.**

2.5 *Podaxis Desvaux* (627)

Bottomley's (1948) placement of this genus in the family Tulostomataceae (order Lycoperdales) has definitely not found widespread acceptance. Most authors, including Zeller (1949), Dissing & Lange (1962), Dring (1964, 1973), Dring & Rayner (1967), De Villiers (1988) and Miller & Miller (1988), place it in the family **Podaxaceae** Corda which Zeller (1949), Dring (1973), De Villiers (1988) and Miller & Miller (1988) believe belongs in the order **Podaxales**.

2.5.1 *Podaxis pistillaris* (Linnaeus ex Persoon) Morse (628)

In terms of article 47.1 of the Tokyo Code, the re-assessment of this species by Morse (1933) '... does not warrant a change of author citation for the name of the taxon', as has been done by Bottomley (1948). The appropriate citation, as employed in Dring & Rayss (1964), Binyamini (1973) and De Villiers *et al.* (1989), adapted here to reflect the changes to the ICBN enacted in 1981 (Korf 1983), is **Podaxis pistillaris** (L.: Pers.) Fr. emend. Morse.

One of the specimens listed in Bottomley (1948) as *P. pistillaris* (PREM 27280), has been described as a new species by De Villiers *et al.* (1989), namely *Podaxis rugospora* De Villiers *et al.*

3. *Nidulariaceae Fries* (631)

According to David (1993) this family name is not attributable to Fries. It should be cited as **Nidulariaceae Dumort.**

3.1 *Crucibulum Tulasne* (631)

Stafleu & Cowan (1986) point out that L.R. Tulasne's brother, Charles, co-authored the work on the Nidulariales and according to Greuter *et al.* (1993), the correct author citation for this name should be **Crucibulum Tul. & C.Tul.**

3.1.1 *Crucibulum vulgare Tulasne* (632)

This name, correctly cited as *Crucibulum vulgare* Tul. & C.Tul., is incorrect (Eckblad 1955; Brodie 1975) and *Crucibulum laeve* is widely accepted as the correct name for this fungus (Eckblad 1955; Brodie 1975; Calonge & Demoulin 1975; Ortega & Buendia 1986; Kreisel 1990; Mornand 1993). All of the aforementioned authors, however, use different author citations. The present authors agree with Kreisel (1990) who cites the name as **Crucibulum laeve** (Huds.) Kambly.

3.2 *Cyathus Haller ex Persoon* (633)

According to Greuter *et al.* (1993) the name *Cyathus* is attributable to Persoon, but, as indicated by Bottomley (1948) and Brodie (1975), the name dates from much earlier. In accordance with the changes to the ICBN enacted in 1981 (Korf 1983), the appropriate author citation, indicating the sanctioned status of this name, should be ***Cyathus Haller: Pers.***

3.2.1 *Cyathus dasypus Nees* (634)

Brodie (1975) regards this as a synonym of *Cyathus olla* (Batsch: Pers.) Pers., stating that '*Cyathus dasypus* from South Africa is surely a form of *C. olla* with extra large irregular peridioles'. The peridiole measurements given in Verwoerd (1928) and Bottomley (1948) are, however, considerably smaller than the dimensions given for *C. olla* in Bottomley (1948), Eckblad (1955), Brodie (1975) and others. In the light of this, Brodie's statement does not make sense and might be worth investigating.

3.2.2 *Cyathus minatosporus Lloyd emend. Verwoerd* (634)

In his authoritative monograph of the Nidulariaceae, Brodie (1975), apparently unaware of the amplified description of this fungus by Verwoerd (1928), lists it as a doubtful species which, according to him, '... cannot legally be recognized as a valid species, but if found again it should be easily recognized by collectors of African material because of the minute spores'.

3.2.3 *Cyathus microsporus Tulasne* (635)

Stalleu & Cowan (1986) point out that L.R. Tulasne's brother, Charles, co-authored the work on the Nidulariales, and consequently, names published therein should be attributed to both brothers. The correct author citation for this name therefore is ***Cyathus microsporus Tul. & C.Tul.***

3.2.4 *Cyathus olla Persoon* (636)

When Persoon (1801) transferred this fungus to the genus *Cyathus*, he simultaneously sanctioned the basionym (Korf 1983). Following Korf's (1983) interpretation of the 1981 changes to the ICBN, the correct author citation for this name therefore is ***Cyathus olla* (Batsch: Pers.) Pers.**

3.2.5 (*C. stercoreus*) forma *Leseurii Tulasne* (638)

Spelling error and incorrect author citation. *Cyathus leseurii* Tul. & C.Tul. has been reduced to synonymy under *Cyathus stercoreus* (Schwein.) De Toni (Lloyd 1906; Brodie 1948; Eckblad 1955; Brodie 1975). Since Lloyd (1906) first assigned it to the form *leseurii* (Brodie 1948), the correct name and author citation are ***Cyathus stercorius* forma *leseurii* (Tul. & C.Tul.) Lloyd.**

3.2.6 *Cyathus Poeppigii Tulasne* (639)

For the reason stated in 3.2.3 this name should be cited as ***Cyathus poeppigii Tul. & C.Tul.***

3.2.7 *Cyathus Montagnei Tulasne* (640)

For the reason stated in 3.2.3 this name should be cited as ***Cyathus montagnei Tul. & C.Tul.***

3.2.8 *Cyathus Berkeleyanus Tulasne* (640)

Brodie (1975) explains that the Tulasne brothers regarded this as a variety of *C. microsporus*, calling it *Cyathus microsporus* var. *berkeleyanus* Tul. & C.Tul. If it is to be treated as a separate species, however, the correct author citation would be ***Cyathus berkeleyanus* (Tul. & C.Tul.) Lloyd.**

4. *Sphaerobolaceae Schroeter* (641)

Although this family has traditionally been treated in the order Nidulariales (Zeller 1949; Eckblad 1955; Dring 1973; Brodie 1975; Dominguez de Toledo 1993), there seems to be an increasing tendency to place it in the order Sclerodermatales (Demoulin 1968; Calonge & Demoulin 1975; Demoulin & Marriott 1981; Ing 1984; Herrera & Perez-Silva 1987; Mornand 1993). According to David (1993) the correct author citation for this family is ***Sphaerobolaceae J.Schröt.***

4.1 *Sphaerobolus Tode ex Persoon* (641)

In accordance with the changes to the ICBN enacted in 1981 (Korf 1983), the appropriate author citation, indicating the sanctioned status of this name, is ***Sphaerobolus Tode: Pers.***

4.1.1 *Sphaerobolus stellatus Tode ex Persoon* (641)

In accordance with the changes to the ICBN enacted in 1981 (Korf 1983), the appropriate author citation, indicating the sanctioned status of this name, and used by authors such as Herrera & Perez-Silva (1987), Hjortstam *et al.* (1993) and Mornand (1993), is ***Sphaerobolus stellatus Tode: Pers.***

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FSA contributions 8: Ceratophyllaceae

C.M. WILMOT-DEAR*

Family **Ceratophyllaceae** *S.F.Gray*, A natural arrangement of British plants 2: 554 (1821).

Aquatic herbs, monoecious, perennating by buds, free-floating; stems branched, often reddish. *Leaves* in whorls of 3–10, filiform, once or more dichotomously branched, often ± rigid and brittle, margins often spinose-dentate, lowest part sometimes swollen and ± sac-like (due to parasite attack), apical segments truncate, 2-spined and with central reddish and glandular projection; stipules 0. *Flowers* unisexual, axillary, male 1(–4), female 1 per node, male and female often at different nodes, ± sessile. *Perianth* lobes (8–)9–12(–15), united at base, some often joined in pairs to over halfway, strap-shaped or obovate, each margin often with single spine or ± lacerate, apex 2-spined and glandular as leaves. *Male flowers*: stamens up to ± 30 in several whorls on domed torus around pistillode; filaments short or 0; anthers oblong, extrorse; loculi 2, parallel, dehiscing longitudinally; connective produced into 2 apical spines and glandular projection; immature anthers flattened, resembling perianth lobes but margins 1–3-spined, mature anthers swollen, glandular projection detached, tissues becoming gas-filled, bearing detached anther to surface where it floats horizontally and dehisces. *Female flowers*: staminodes 0; ovary superior, sessile, ovoid, tapering to long style; ovule 1, pendulous. *Fruit*: an achene, ovoid or ellipsoid, slightly laterally flattened, sometimes sufficiently to form a marginal rim or crenate to spiny wing, a pair of basal spines often present, surface smooth, spiny or warty; style ± persistent, forming a distinct terete apical spine; embryo straight, endosperm absent.

A worldwide family of one genus only.

2516000 CERATOPHYLLUM

Ceratophyllum *L.*, Species plantarum 1: 992 (1753); Agnew: 81 (1974); Hauman: 165 (1951); A.Raynal: 103 (1980); Wilmot-Dea: 243 (1985a); Wilmot-Dea: 1 (1985b); Wilmot-Dea: 124 (1991); Symoens & Wilmot-Dea: 212 (1996). Type species: *C. demersum* *L.*

Description as for family.

Ceratophyllum is a more or less cosmopolitan genus, here considered to comprise three very widespread species. Past authors have recognized between one and more than 10 species, although most have accepted three. Recent revisions have all subdivided it into three ‘groups’, whose types are respectively *C. demersum* *L.*, *C. submersum* *L.* and *C. muricatum* *Cham.*, but have recognized these groups at differing taxonomic rank. Les (1986, 1989) treats them as three sections, within which six species and several further infraspecific taxa are recognized. Wilmot-Dea (1985a) treated them as species or subspecies, reducing the *C. muricatum* ‘group’ to a subspecies of *C. submersum* in recognition of their extreme vegetative similarity and the existence (sometimes in the same one population) of a range of intermediate fruit forms, both of which facts suggest a very close affinity between the two taxa. However, taking into account all recent work, it seems more satisfactory to recognize *C. demersum*, *C. submersum* and *C. muricatum* at the rank of species, each having a typical form which is geographically widespread and to which belong most of the specimens collected; in each group other infraspecific taxa, of restricted distribution, are also recognized. In southern Africa only *C. demersum* *L. sensu stricto* and *C. muricatum* *Cham. sensu stricto* have been positively identified. The third species, *C. submersum*, which is very similar to *C. muricatum* but differs in lacking basal spines on its fruit, may also occur here. All fruits seen from southern Africa, however, had basal spines (see also notes under *C. muricatum*).

- 1a Leaves branching twice, rarely once or (only in lower parts, especially of main axis) thrice, spiny teeth on margin often many, prominent; mature fruit with long apical spine and 2 prominent basal spines, lateral flattening of fruit slight, surface ± smooth 1. *C. demersum* var. *demersum*
- 1b Leaves, at least the majority on all parts of plant, branched 3–4 times, spiny teeth on leaf margin few, always small, inconspicuous; fruit with long or very short apical spine, with or without basal and marginal spines, lateral flattening of fruit ± well marked, forming a longitudinal marginal rim or wing, surface strongly papillose or warty:
- 2a Fruit with distinct, irregularly crenate to spinulose marginal wing; basal spines present, apical spine (1–)4–9 mm long; surface with abundant, often ± elongated warty papillae 2. *C. muricatum* subsp. *muricatum*
- 2b Fruit with ± distinct marginal rim but without wing; basal spines absent, apical spine up to 15(–20) µm long; surface with numerous tiny warty-prickly papillae giving bristly appearance especially along marginal rim (occurrence in southern Africa unconfirmed) 3. ?*C. submersum* var. *submersum*

1. **Ceratophyllum demersum** *L.*, Species plantarum 1: 992 (1753); J.M.Wood: t. 551 (1912); Engl.: 206 (1914); Skan: 326 (1917); Skan: 580 (1925); Robyns: 167 (1948); F.W.Andrews: 14, t. 13 (1950); Cufod.: 106 (1953); Keay: 65 (1954); Friedr.-Holzh.: 1 (1968); Lind & Tallantire: 114 (1971); J.H.Ross: 168 (1972); R.A.Dyer: 152 (1975); Wilmot-Dea: 3 (1985b); Wilmot-Dea: 125 (1991); Symoens & Wilmot-Dea: 214 (1996). Type: *Hortus cliffortianus* 446 (BM, lecto.!).

Aquatic herb to 3 m long; main stem to 2 mm diam., delicate to robust and wiry. *Leaves* bright or olive green, 7–11 per whorl, 8–40 mm long, (once–) twice-dichotomous (in lower part of plant sometimes 3 times dichotomous), 0.2–0.7 mm (lowest segments sometimes to 1 mm)

* The Herbarium, Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AB, England.
MS. received: March 1984.

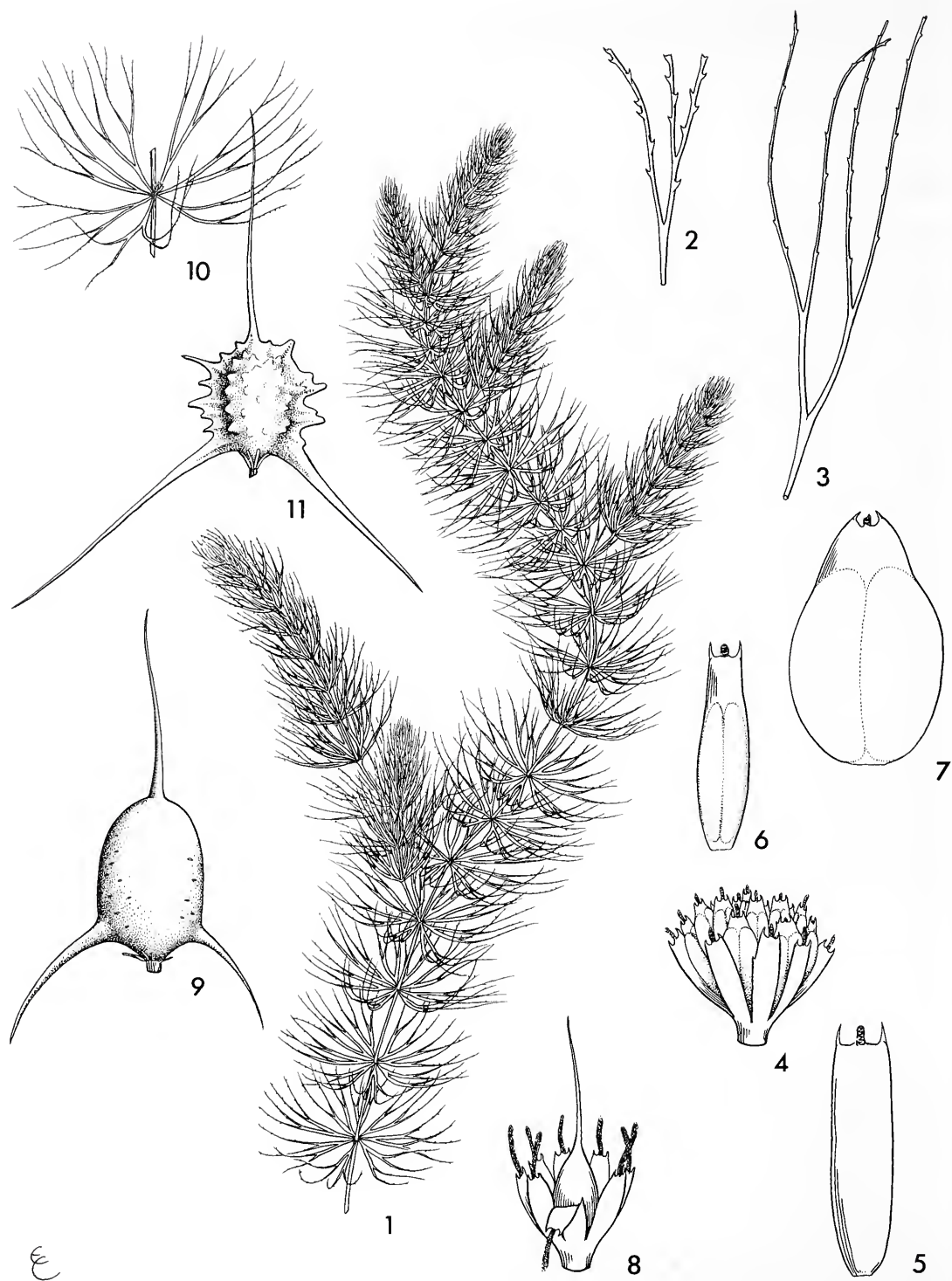


FIGURE 1.—*Ceratophyllum demersum* var. *demersum*, 1.1–1.3; 1.8, 1.9: 1.1, part of plant, $\times \frac{2}{3}$, Mauve 4269; 1.2, leaf, $\times 2$, Musil 450; 1.3, leaf, $\times 2$, Ward 6582; 1.8, female flower, $\times 8$, Bogden 2333; 1.9, fruit, $\times 4$, Ward 6582. *C. muricatum* subsp. *muricatum*, 1.4–1.7, 1.10, 1.11: 1.4, male flower, $\times 8$; 1.5, male perianth segment, $\times 24$; 1.6, immature anther, $\times 24$; 1.7, mature anther, $\times 24$; 1.10, position of stem showing leaf-whorl, $\times \frac{2}{3}$, all from Stephens 31; 1.11, var. *echinatum*: fruit, Van der Schijff 5672. Published with permission of Director, Royal Botanic Gardens, Kew.

thick, apical and often lower segments with many, rarely few, spine-tipped marginal teeth (0.1–)0.2–0.5 mm long. *Male flowers* 1–3 per node, often many per branch, up to 2.5(–3.5) mm in diam.; *perianth* broadly cup-shaped, lobes 0.5–1.3 × 0.2–0.4 mm, glandular projection to 0.2 mm long; *stamens*: up to ± 30, anthers subsessile, 1–2 × 0.4–1.5 mm when mature; pistillode ± 0.6 mm long. *Female flowers* solitary, few per branch; *perianth* closely surrounding ovary, persistent in fruit, lobes resembling male, glandular projection to 0.7 mm long. *Ovary* to 1.0 × 0.6 mm, smooth; style usually over 2 mm long. *Fruit* dark green or red-brown at maturity, surface smooth or finely papillose; basal spines usually long and conspicuous, sometimes reduced or absent.

var. *demersum*

Ceratophyllum oxyacanthum Cham.: 504, t. 5, fig. 6b (1829); non Schur. *C. demersum* var. *oxyacanthum* (Cham.) K.Schum.: 748 (1894); Engl.: 178 (1895). Type: Berlin, 1829, *Chamisso s.n.*, (B, holo.; K, photo. of holo.).

C. tuberculatum Cham.: 504, t. 5, fig. 6d (1829). Type: India, Trankebar [Tranquebar], Feb. 1798, *Klein 506 (3281) in Herb. Willd. 17546* (B-WILLD, holo.; IDC Microfiche No. 7440–29/1267: 1.3–6!).

Fruit very slightly laterally flattened and without marginal rim, (3.5–)4.0–5.5 × 3.0–3.5 mm; apical spine (1.5–)3.5–9.0 mm long; basal spines (0.5–)1.5–6.0 mm long; surface ± smooth, yellow-green becoming red-brown, with sparse or numerous slightly raised dark gland-dots. Figure 1.1–1.3; 1.8, 1.9.

Found scattered in Caprivi Strip (Namibia), Botswana (mainly towards north), Northern Province, Gauteng, Mpumalanga, Swaziland, Free State and coastal regions of Western and Eastern Cape; abundant along coastal region of KwaZulu-Natal (Figure 2); of almost worldwide distribution. Occurs in static to fast-flowing shallow or deep water, reed swamps, lakes, rivers, streams; tolerant of brackish estuarine conditions of high salinity but not found in seasonal, highly alkaline pools.

Vouchers: Allen 416; Mauve 4269; Ward 7491; Van Son 28791.

2. *Ceratophyllum muricatum* Cham. in *Linnaea* 4: 504, t. 5, fig. 6c (1829). Type: Egypt, Danielta, June 1821, *Sieber s.n.* [B, holo.†; HAL, lecto. (designated in Les: 296 (1986); K, G, iso.!).

C. demersum L. var. *muricatum* (Cham.) Hook.f. ex K.Schum.: 749 (1894).

C. submersum L. subsp. *muricatum* (Cham.) Wilmot-Dear: 266 (1985a).

Aquatic herb similar to *C. demersum* but usually more delicate and differing as follows: *Leaves* usually lighter green, 13–40 mm long, 3–4 times (rarely only twice in some whorls) dichotomously branched, 0.1–0.3 mm (lower segments sometimes to 2.5 mm) thick, marginal spiny teeth few, rarely numerous, inconspicuous, up to 0.1 mm to 0.2 mm long, often absent from 2 lower segments. *Flowers* resembling those of *C. demersum*, differing as follows: *male flowers* generally 2 per node, often at same node as female, diameter to 2 mm; anthers 8–15, often smaller and relatively broader, 0.6–0.8 × 0.4–0.7 mm. *Female perianth lobes* relatively narrower and usually longer, (1.5–)1.8–2.0 × 0.1–0.3 mm. *Fruit* dark green or brown at maturity, surface usually warty or papillose or

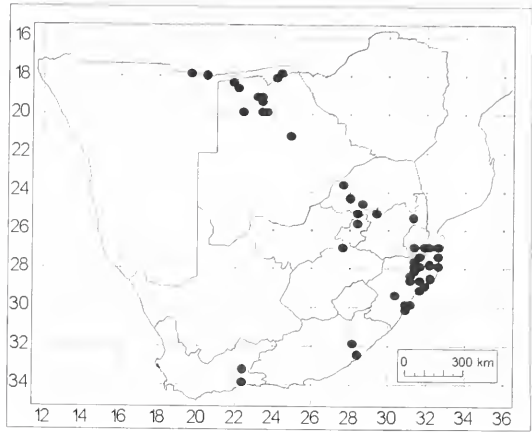


FIGURE 2.—Distribution of *Ceratophyllum demersum* var. *demersum* in southern Africa.

sometimes with winged spines, lateral flattening sufficient to form a distinct crenate or spiny wing with spines sometimes longer than basal spines. Figure 1.4–1.7, 1.10.

Recent authors have treated the *C. muricatum* group in various ways. However, whichever system is adopted, the taxon found in Africa corresponds to the type of *C. muricatum*.

subsp. *muricatum*

C. cristatum Perr. & Guill.: 296 (1833). Type: Senegal, circa Khan and N. 'Batel, ad peninsulam promontorii Vindis, March ?1833. *Guillemin & Perrotet s.n.* (P, holo.; K, iso.).

C. submersum subsp. *muricatum* (Cham.) Wilmot-Dear var. *echinatum* (A.Gray) Wilmot-Dear: 266 p.p. (quoad specimina palaeotropica) (1985a); Wilmot-Dear: 126 (1991).

C. demersum sensu auctt. non L.: Skan: 327 (1917) p.p.; Keay: 65 (1954) p.p.

Fruit markedly laterally flattened with marginal rim widened into ± entire or irregularly crenate to long-spiny nose wing, ellipsoid, 3.0–4.5 × 2.0–3.0(–3.5) mm; apical spine (1–)4–9 mm long; 2 basal spines (0.5–)2.0–6.0(–10) mm long; surface rarely smooth, usually with (few–) many small, rounded to ± elongate warty papillae up to 0.2 mm long or sometimes with spines up to 0.3 mm high. Figure 1.11.

Found in Mpumalanga and probably also elsewhere in southern Africa (Figure 3; see note below on non-fruiting material); Senegal, Ghana, Chad, Sudan, ?Mozambique (fruit immature), India and Pacific Islands. Occurs mainly in slow-flowing or stagnant water including seasonal highly alkaline lakes and pools; not found in brackish estuarine conditions.

Voucher: Van der Schijff 5672.

Only one of all southern African specimens seen with 3–4 times dichotomous leaves was in fruit and was positively identified as *C. muricatum* subsp. *muricatum*. The identity of the remainder could not be determined for certain and it is possible that some of them belonged to *C.*

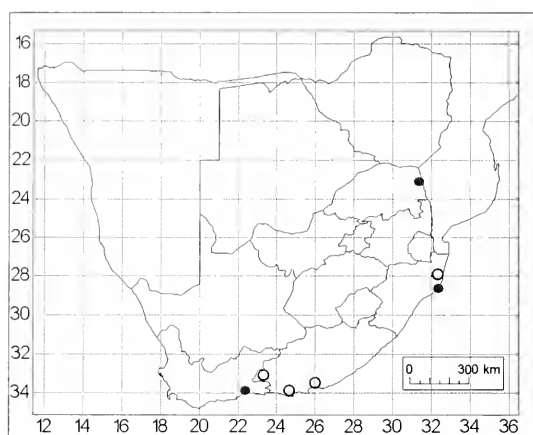


FIGURE 3.—Distribution of *Ceratophyllum muricatum* subsp. *muricatum* in southern Africa: fruiting material of certain identity, ●, non-fruiting material of uncertain identity, ○.

submersum var. *submersum*, which occurs in parts of Africa in the same habitat and is vegetatively almost identical. A brief description of this taxon is therefore given below and it also appears in the key.

Sterile material with 3–4 times dichotomous leaves is found (rather rarely) in eastern KwaZulu-Natal and southern coastal regions of Western and Eastern Cape (Figure 3).

Vouchers (specimens without fruit): *Levyns* 752 (BOL); *Stephens* 31.

3. ?*Ceratophyllum submersum* L., *Species plantarum* edn 2: 1409 (1753); Hauman: 165 (1951); A. Raynal: 103 p.p. (1980); Wilmot-Dear: 4 (1985b); Les: 278 (1986); Wilmot-Dear: 126 (1991); Symoens & Wilmot-Dear: 216 (1996). Lectotype: Vaill.: 16 [not 21 as cited in L.: 1409 (1763)], t. 2, fig. 2(2) (1719).

Aquatic herb almost identical to *C. muricatum* except in fruit. *Flowers*: male with usually less than 10 stamens. *Fruit* 4.5–6.0 × 3.5–4.0 mm, surface with minute papillae or irregular, elongated warts, rarely ± smooth; lateral flattening sufficient to form a rim, this ± warty but never winged or spinose; basal and lateral spines completely absent.

Wilmot-Dear (1985a) considered subsp. *submersum* (which corresponds to *C. submersum* as conceived here) to comprise three varieties, of which only the typical one is widespread and known from Africa. Les (1986) did not consider the other two varieties as distinct.

var. *submersum*

Fruit markedly laterally flattened with ± distinct longitudinal 'marginal' rim, ellipsoid, 3–5 × 2.5–3.0 mm; apical spine 0.45–1(–2) mm long; surface rarely smooth,

usually with numerous minute warty papillae especially along rim, giving prickly appearance.

Found in Cameroons, Zaïre, east tropical Africa, perhaps southern Africa, Dominica, parts of Europe and Asia.

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Two new species of *Zygophyllum* (Zygophyllaceae) from the Western Cape, South Africa

L. VAN ZYL (née HUGO)* and E.M. MARAIS*

Keywords: new species, South Africa, Western Cape, Zygophyllaceae, *Zygophyllum*

ABSTRACT

Two new species of *Zygophyllum* L. from the Western Cape are described, namely, *Z. fuscatum* Van Zyl from the coastline between Betty's Bay and De Hoop Nature Reserve and *Z. botulifolium* Van Zyl from the Tanqua Karoo.

INTRODUCTION

Sonder (1860) in *Flora capensis*, recognized 25 species in his revision of the genus *Zygophyllum* in southern Africa. Van Huyssteen (1937) added a few more new species. Since then many more new taxa from all over the distribution range of the genus have come to light and in this paper two new species are dealt with. Both belong to the subgenus *Zygophyllotypus* Huysst., section *Capensia* Engl. which is by far the largest section of the southern African species of *Zygophyllum*.

Young stems of species in section *Capensia* are mostly not round in cross section but flat on one side and they nearly always display lateral ridges containing vascular bundles which presumably serve the stipules. The flat area with lateral ridges occurs along the whole length of the internode. This side of the young stem could be described as nearest to the central axis of the shrub, and therefore the descriptive term, ventral, is used with this situation in mind. Members of another section of *Zygophyllum*, namely section *Alata*, often display a distinct ventral groove along the whole length of the internode. Figure 1.

***Zygophyllum fuscatum* Van Zyl, sp. nov.**, (§ *Capensia*), *Z. fulvo* L. affinis sed frutex erectus ramulis dense foliaceis secundis, fructibus angulatis et costatis. Figura 2.

Frutex erectus multicaulis. Ramuli dense foliacei, secundi, internodia ventraliter complanata, costis lateralibus angustis in lobum distinctum acutum distalem terminantibus. Folia opposita, subsessilia, bifoliolata, foliola elliptica vel obovata, in sicco nigrescentia. Pedicelli brevissimi, 1–2 mm longi; petala flavissima. Squamae staminum simplices, oblongatae, margine fimbriato, longitudine $\frac{1}{3}$ filamentorum partes aequantes. Ovarium 5-angulatum. Fructus capsula loculicida oblonga, 5-angulata et 5-costata. Semen arillo albo, testa madida mucum procreans.

TYPE.—Western Cape, 3419 (Caledon): coastal dunes between Kleinbaai and Danger Point, (–CB), May 1992, Van Zyl 4293 (NBG, holo.; B, PRE, S).

Erect, multistemmed, branched, glabrous shrub up to 1.0 m high and 1.5 m in diameter. *Stems:* old stems leafless, dark grey, up to 20 mm thick; young branches green, densely leafy, secund, internodes ventrally flattened with narrow lateral ridges, each ending in a distinct, acute, distal lobe (Figure 2D). *Leaves* opposite, subsessile, bifoliolate, khaki or yellow green, when dried changing colour to dark brown or nearly black; leaflets articulate, elliptic to obovate, not succulent, 12–16 × 2–5 mm, apex rounded or acuminate, with an apiculum, base cuneate; stipules interpetiolar, membranous, caducous, subrotund, sometimes slightly notched, 0.5–1.5 × 1–2 mm. *Flowers* solitary or seldom two together, axillary. *Pedicel* 1–2 mm long. *Sepals* 5, ovate to elliptic, attenuate, 6–8 × 3–4 mm. *Petals* 5, patent, subrotund or elliptic, 10–14 × 5–7 mm, apex round or acuminate, base with a short claw, deep yellow and variously marked at base with red or brown, or without any markings. *Nectar disc* fleshy, papillose, 10-angled. *Stamens* 10; filaments terete, 5.5–8.0 mm long; staminal scales 10, simple, oblong, margins unevenly lacerate, 2–3 × 1.0–1.5 mm, ± one third as long as filament. *Ovary* 5-angled and 5-locular; style terete; stigma simple. *Fruit* an oblong, 5-angular and 5-ribbed, few-seeded, loculicidal capsule, 12–14 × 11–12 mm. *Seed* oblong, up to 3 per locule, 4 × 2 mm, dark brown with white aril, testa producing mucilage when wet.

Diagnostic characters

Zygophyllum fuscatum resembles *Z. fulvum* L. and *Z. flexuosum* Eckl. & Zeyh. but is readily distinguished from the former by its erect, shrubby habit, densely leafy,

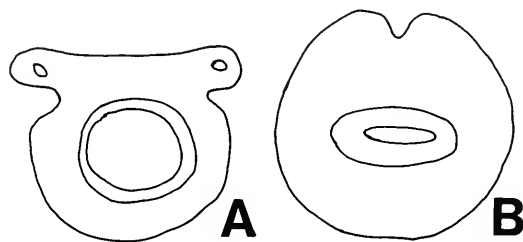


FIGURE 1.—Section through internode. A, *Z. fuscatum*, Van Zyl 4293 (section *Capensia*); B, *Z. suffruticosum* Schinz, Van Zyl 3809 (section *Alata*).

* Department of Botany, University of Stellenbosch, Private Bag X1, Matieland, 7602 Stellenbosch.
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FIGURE 2.—*Zygophyllum fuscatum*, Van Zyl 4293, holotype. A, flowering branch; B, fruiting branch; C, sideview of leaflets; D, leaflet arrangement, lateral ridges and distal lobe on internode; E, section of internode; F, sepal; G, petal; H, section of capsule; I, stamen with scale; J, ovary; K, section of ovary.

second young branches which turn dark brown or nearly black when dried, (hence the specific epithet which is Latin for brown tinged with black), also by the absence of scabrous leaf margins, which are characteristic of *Z. fulvum*. The internodes of young stems are always flat on the ventral side and have narrow, lateral ridges ending in distinct, acute distal lobes. These ridges are present in all three taxa mentioned above but only *Z. fuscatum* displays these distinctive lobes. The very short pedicels

(1–2 mm) of *Z. fuscatum* also differ from those of *Z. fulvum* and *Z. flexuosum* which vary from 9–20 mm. The oblong, 5-angled and 5-ribbed, loculicidal capsules of *Z. fuscatum*, with up to three seeds per locule, differ markedly from those of *Z. fulvum* which are subrotund, without angles, showing only faint remains of sutures, and those of *Z. flexuosum*, distinguished by being wider than long, and containing only one, extremely sticky seed per locule.

Distribution and habitat

Z. fuscatum is found in a narrow strip along the southern Western Cape coastline, from Betty's Bay in the west to De Hoop Nature Reserve in the east, mostly in close proximity to the sea, from sea level to about 300 m altitude (Figure 3). The vegetation is classified as Limestone Fynbos by Rebelo (1996) and is restricted to calcareous, neutral to alkaline, shallow sands overlying limestone and associated calcretes of the Bredasdorp Formation. The area falls within the winter and autumn-spring rainfall area, with rainfall varying from 350 to 600 mm per year and with average daily temperatures of 17°C. Also found in this area are two other *Zygophyllum* species, namely *Z. fulvum* L. and *Z. flexuosum* Eckl. & Zeyh. *Z. fuscatum* thrives in direct sunlight and is often seen as a pioneer in disturbed areas along roadsides. Populations of many scattered individuals exist, including seedlings and young plants. *Z. fuscatum* is fairly common where found and under no threat of extinction. Flowering occurs from May to August and fruits are shed a month or two later.

Specimens examined

WESTERN CAPE.—3418 (Simonstown): Holbaai Peninsula, E of Hangklip, (–BD), June, *Rourke 423* (NBG); E of Blesberg, Hangklip, (–BD), Sept., *Boucher 684* (NBG); Betty's Bay, (–BD), June, *Hall 1738* (NBG); 3419 (Caledon): Danger Point, Caledon, (–CB), June, *Lewis 4025* (SAM); June, *Martin 338* (NBG); near Die Kelders, (–CB), May, *Van Zyl 4294* (NBG); coastal dunes, W of Kleinbaai, (–CB), May, *Van Zyl 4292* (NBG); coastal dunes between Kleinbaai and Danger Point, (–CB), May, *Van Zyl 4293* (B, NBG, PRE, S); coastal fynbos at Buffelsjag, Quoin Point, (–DC), July, *Van der Zeyde 54/83* (NBG); near Ratel River mouth, (–DC), June, *O'Callagan, Van Wyk & Fellingham 471* (NBG); near Quoin Point, Buffelsjag, (–DC), May, *Van Zyl 4290* (NBG); 3420 (Bredasdorp): Dronkvlei flats, De Hoop Nature Reserve, (–AD), June, *Burgers 1854* (NBG); near Arniston, (–CA), July, *Marsh 1452* (PRE, NBG); coastal dunes near Bredasdorp, (–CA), Aug., *Van Breda 814* (PRE).

***Zygophyllum botulifolium* Van Zyl, sp. nov.** (§ *Capensia*), frutex erectus a speciebus aliis sectionis foliis cylindricis, succulentibus distinguitur. Figura 4.

Frutex erectus, multicaulis. *Internodia* ventraliter complanata, leviter costata. *Folia* opposita, sessilia, bifoliolata; foliola cylindrica, succulenta. *Petala* sulphurea vel aurea. *Squamae* staminum simplices, ellipticae, margine fimbriato, filamentis dimidia parte breviores. *Ovarium* 5-angulatum. *Fructus* capsula loculicida, subrotunda, 5-angulata et 5-costata. *Semen* arillo albo, testa madida mucum procreans.

TYPE.—Western Cape, 3319 (Worcester): Doornrivier crossing between Ceres and Sutherland, (–BB), September 1989, *Van Zyl 3935* (NBG, holo.; B, BOL, PRE, S, WIND).

Erect, compact, branched, woody shrub, up to 0.6 m high and 0.6 m in diameter. *Stems*: old stems woody, dark grey, resprouting at nodes, young branches green, ventrally flattened, with weakly developed lateral ridges on internodes. *Leaves* opposite, sessile, bifoliolate, dark green, sometimes with brown tints; leaflets articulate, cylindrical, succulent, 7–13 × 2–3 mm, apex and base rounded; stipules interpetiolar, membranous, caducous, triangular, 1.0–1.5 mm. *Flowers* solitary, axillary. *Pedice*

7–10 mm long. *Sepals* 5, ovate, 7–8 × 3 mm, light green. *Petals* 5, patent, elliptic to subrotund, 9–11 × 4–5 mm, with short claws, sulphur-yellow to rich golden yellow, variously marked in red, brown or khaki at base. *Nectar disc* fleshy, papillose, 10-angled. *Stamens* 10; filaments terete, 5–7 mm long; staminal scales simple, elliptic, 3–4 × 1.0–1.5 mm, more or less half as long as filament, margins long fimbriate. *Ovary* oblong, 5-angled; style terete; stigma simple. *Fruit* a subrotund, 5-angled and 5-ribbed, loculicidal, few-seeded capsule, 11 × 10 mm. *Seed* oblong, 4.0–2.5 mm, dark brown, white aril present, testa granular, producing mucilage when wet.

Diagnostic characters

Zygophyllum botulifolium is distinguished by its very succulent, cylindrical leaflets (hence the specific epithet which is Latin for sausage-leaved), a feature in which it resembles the dwarf shrubs of the Mesembryanthemaceae amongst which it is always found. *Z. simplex* also has succulent but not cylindrical leaves and these two species should not be confused with one another because of their very different habit: *Z. simplex* is a prostrate annual whereas *Z. botulifolium* is an erect, woody shrub. Although the young stems of *Z. botulifolium* are flat on the ventral side, the lateral ridges on the internodes are poorly developed compared to other members of section *Capensia*. It is further distinguished by the staminal scales with long, fimbriate margins and by the subrotund, 5-angled and 5-ribbed capsule. This species has no close affinities with other members of the section *Capensia*.

Distribution and habitat

Z. botulifolium is restricted to the southern part of the Tanqua Karoo and, according to distribution records, is found together with only one other *Zygophyllum* species, namely *Z. retrofractum* Thunb. which belongs to subgenus *Agrophyllum* Huysst. The vegetation of the Tanqua Karoo is classified as Lowland Succulent Karoo by Hoffman (1996), or Tanqua Karoo by Acocks (1988), and contains a high succulent plant species diversity. According to Acocks (1988) the valleys of the Tanqua

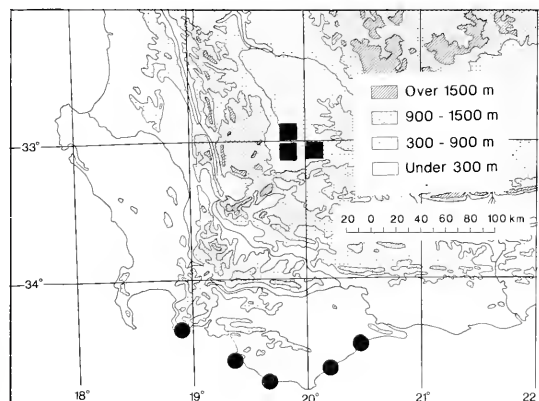


FIGURE 3.—Distribution of *Zygophyllum fuscatum* Van Zyl, ●; *Z. botulifolium* Van Zyl, ■.

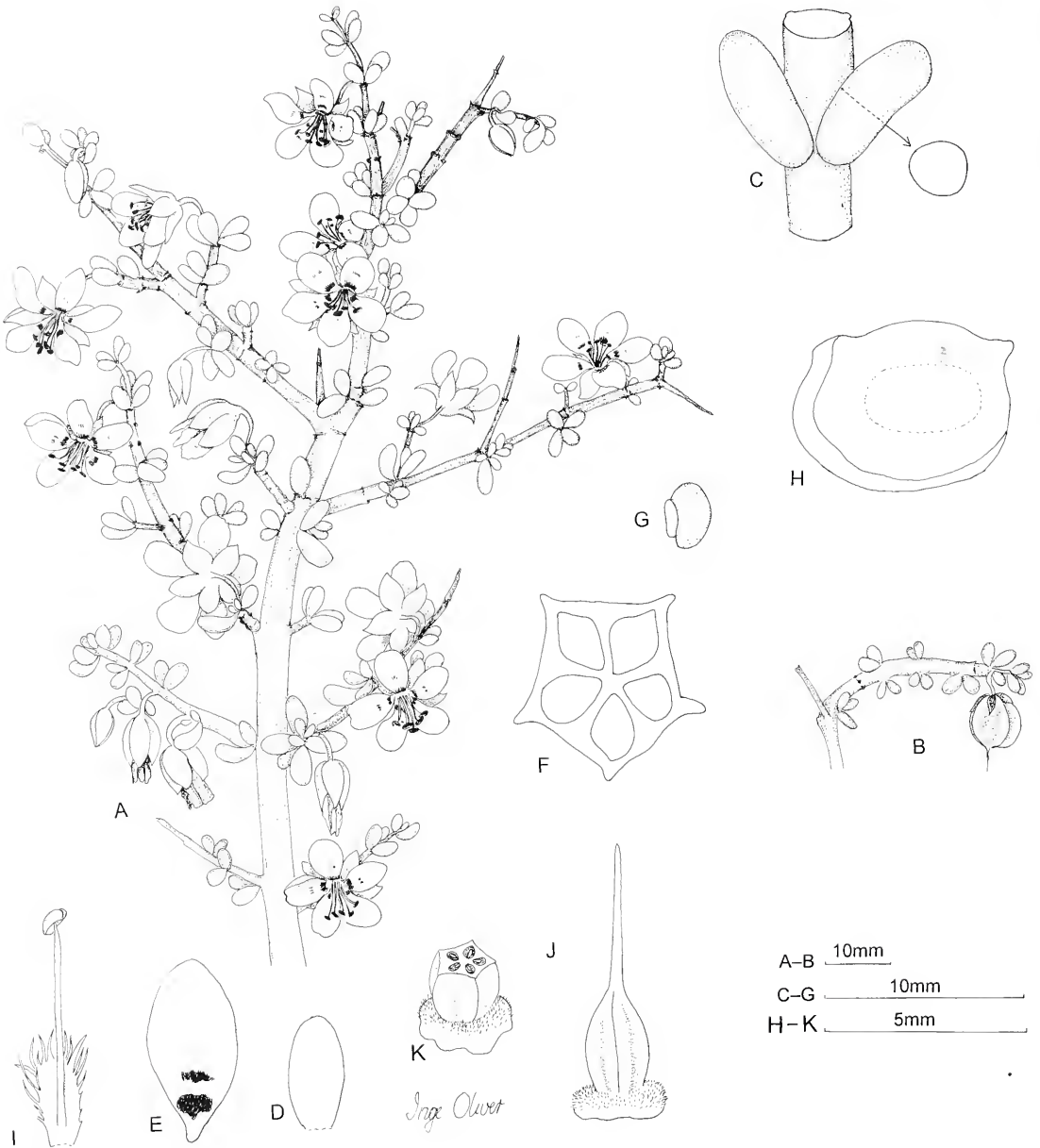


FIGURE 4.—*Zygophyllum botulifolium*, Van Zyl 3935, holotype. A, flowering branch; B, fruiting branch; C, leaflets with cross section; D, sepal; E, petal; F, section of capsule; G, seed; H, section of internode; I, stamen with scale; J, ovary; K, section through ovary.

and Doorn Rivers are flat country, mostly 300–450 m above sea level, and receive less than 150 mm rain per annum, falling mostly in winter. The lower parts of these valleys can be considered as being almost total desert. It is quite normal to find very few flowers and even fewer fruits on shrublets of *Z. botulifolium*. Over a period of nearly 10 years, during which collections were made, this was mostly the case with the exception of one good rainy season when plants were found covered in flowers and fruits. Populations of *Z. botulifolium* consist of a few dozen scattered plants which are usually found near dry stream beds, mostly tributaries of the Doorn River. In a sterile state this species may be mistaken for a shrublet of the Mesembryanthemaceae. Most plants are heavily

grazed and have a gnarled, pruned appearance. The fact that plants are edible and that the whole of the distribution range falls within sheep farming area, could account for the near absence of seedlings or young plants. Because of the small size of populations and grazing pressure, this species could be considered as vulnerable. Flowering takes place from July to August.

Specimens examined

WESTERN CAPE.—3219 (Wuppertal): Grootrivierloop at Soutpanskoppies, Ceres Karoo, (–DD), July, Van Zyl 4200 (NBG, PRE). 3319 (Worcester): Doornrivier crossing between Ceres and Sutherland, (–BB), Sept., Van Zyl 3935 (B, BOL, NBG, PRE, S, WIND); Doornrivier crossing between Ceres and Sutherland, (–BB),

July, *Van Zyl 4026* (NBG, PRE); near Doornrivier, Ceres, (–BB), Sept., *Van Zyl 3742* (NBG, PRE); Doornrivier crossing between Ceres and Sutherland, (–BB), Sept., *Van Zyl 4237* (NBG, PRE); between Inverdoorn and Tweeriviere, Ceres Karoo, (–BB), Aug., *Van Zyl 4238* (NBG). 3320 (Montagu): between Toorberg and Perdekraal, (–AA), Nov., *Van Zyl 4153* (NBG, PRE).

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Notes on African plants

VARIOUS AUTHORS

CACTACEAE

RHIPHALIS BACCIFERA SUBSP. MAURITIANA: THE CORRECT NAME FOR THE INDIGENOUS SOUTHERN AFRICAN CACTUS

Apart from about 20 naturalized species of Cactaceae, most of which are noxious weeds, e.g. *Opuntia ficus-indica* (L.) Mill., southern Africa has only a single indigenous cactus species. The species, *Rhipsalis baccifera* (J.S.Mill.) Stearn (Figure 1), occurs in the subtropical eastern parts of the subcontinent (Figure 2) and is, according to Obermeyer (1976), plentiful in the northeastern Cape (Eastern Cape Province), Zululand and southern Natal (KwaZulu-Natal). The genus *Rhipsalis* Gaertn. comprises 33 species (Barthlott & Taylor 1995) and occurs over much of the New World tropics. *R. baccifera*, the only Old World representative of the genus, and indeed of the family, was treated for the *Flora of southern Africa* by Obermeyer (1976) who interpreted the species as a single variable entity. Barthlott (1987), on the other hand, split *R. baccifera* into three subspecies, including the typical subspecies. This taxonomic refinement resulted in the species, as it is known in southern Africa, being included in *R. baccifera* subsp. *mauritiana* (DC.) Barthlott. In a recent note, precursory to a monographic treatment of the tribe Rhipsalideae of the Cactaceae, Barthlott & Taylor (1995) divided *R. baccifera* into six subspecies, but prudently added that their treatment should be regarded as provisional only, as this complex species required further investigation. Since this further refinement will have no effect on the correct name of the southern African representatives of the species, the treatment of Barthlott (1987) will be incorporated into PRECIS, the comprehensive southern African plant taxonomic database. Following the treatment of Barthlott (1987), the nomenclature of the indigenous southern African cactus

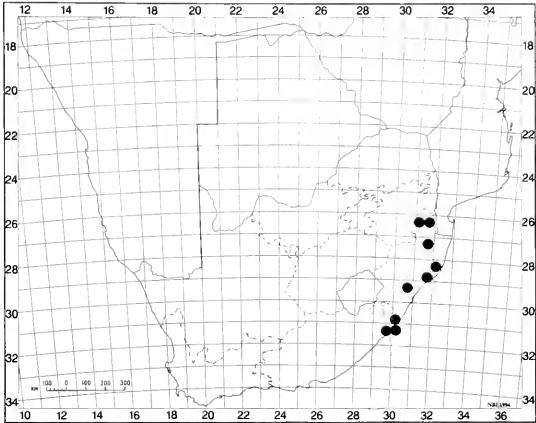


FIGURE 2.—Distribution map of *Rhipsalis baccifera* subsp. *mauritiana* in southern Africa.

is as follows:

5416000-2[†] *Rhipsalis baccifera* (J.S.Mill.) Stearn subsp. **mauritiana** (DC.) Barthlott: 100 (1987); Barthlott & Taylor: 64 (1995). Type: lectotype designated by Barthlott & Taylor (1995): Mauritius, Le Pouche, Sieber [fl. maur. 2:] 259 (G-IDC microfiche; L, lectopara.).

R. cassytha (var.) *mauritiana* DC.: 476 (1828).

A distribution map of *Rhipsalis* in southern Africa was not included in Obermeyer (1976), and is given here for the sake of completeness (Figure 2). The palaeotropical distribution of *Rhipsalis* was depicted by Barthlott (1983: fig. 2).

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G.F. SMITH* and E.M.A. STEYN*

* Research Directorate, National Botanical Institute, Private Bag X101, Pretoria 0001.
MS. received: 1997-01-13.
† See Germishuizen (1997: *Bothalia* 27: 146).

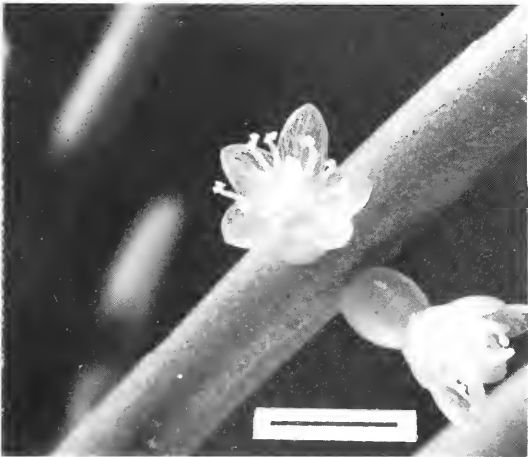


FIGURE 1.—Flowers of *Rhipsalis baccifera* subsp. *mauritiana*, G. F. Smith 110 (PUC). Material collected near KwaMabeyana on the Ozwatini Plateau in central KwaZulu-Natal. Scale bar: 10 mm.

BRYOPHYTA

NEW AND INTERESTING RECORDS OF MOSSES IN THE FLORA OF SOUTHERN AFRICA AREA:
4. NEW RECORDS AND GEOGRAPHIC REGIONS

This is the fourth report of new and interesting records of mosses from regions inside the *Flora of southern Africa (FSA)* area, comprising Botswana, Lesotho, Namibia, South Africa and Swaziland. The records are listed in the same order and form as previously (Van Rooy & Perold 1990, 1992a, b) except that the genera are now alphabetically arranged under each family. This report also includes new records for regions referred to in *Memoirs of the Botanical Survey of South Africa* No. 62—Plants of southern Africa: names and distribution (Van Rooy 1993).

The geographic regions referred to in the previous reports (Van Rooy & Perold 1990, 1992a, b) are the same as those presented in the first two fascicles of the Bryophyta in the *Flora of southern Africa* (Magill 1981, 1987). To reflect recent constitutional developments in southern Africa some of these regions, partly demarcated by former provincial boundaries, have been changed. The changes have, however, been kept to a minimum for the sake of continuity. The former western Transvaal region now forms part of the northern Cape region, and the former Transkei region has been added to the eastern Cape region (Figure 3). The name of the South West Africa/Namibia region has been changed to Namibia, that of the Orange Free State region to Free State, and that of Natal to KwaZulu-Natal. The name Zululand is retained for the northern part of KwaZulu-Natal Province. The 'Cape' and 'Transvaal' regions referred to in this report no longer coincide with the former Cape and Transvaal provinces of South Africa.

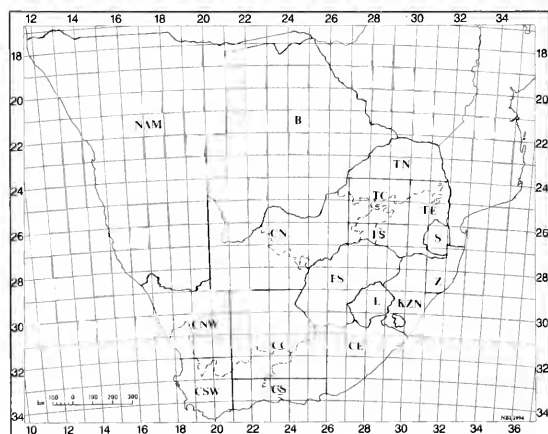


FIGURE 3.—Amended geographical regions for the moss flora of southern Africa. B—Botswana, CC—central Cape, CE—eastern Cape, CN—northern Cape, CNW—northwestern Cape, CS—southern Cape, CSW—southwestern Cape, FS—Free State, KZN—KwaZulu-Natal, L—Lesotho, NAM—Namibia, S—Swaziland, TC—central Transvaal, TE—eastern Transvaal, TN—northern Transvaal, TS—southern Transvaal, Z—Zululand (northern KwaZulu-Natal).

FISSIDENTACEAE

Fissidens

- rufescens Hornsch. (Magill 1981: 47)
Namibia, first record in PRE with a precise locality (1917 DA: Smook 8983).
- usambaricus Broth. (Magill 1981: 43)
Swaziland (2631 AA: Braun 1456).

ARCHIDIACEAE

Archidium

- acanthophyllum Snider (Magill 1981: 75)
Swaziland (2631 AB: Smook 8885).
- globiferum (Brid.) J.-P.Frahm (as *A. ohioense* in Magill 1981: 74)
Free State (2827 DC: Van Rooy 515).

DITRICHACEAE

Ditrichum difficile

- (Duby) M.Fleisch. (Magill 1981: 93)
Central Transvaal (2527 CD: Glen 3173).

DICRANACEAE

Trematodon

- divaricatus Bruch ex C.Krauss (Magill 1981: 114)
Southern Cape (3323 DC: Powrie 234).
- longicollis Michx. (Magill 1981: 115)
Southern Cape (3321 AC: Perold 3285).

POTTIACEAE

Bryoerythrophyllum campylocarpum (C.Müll.) H.A.Crum (as *B. jamesonii* in Magill 1981: 248)

- Southern Transvaal (2628 DA: Glen 2847).
- Hymenostylium recurvirostrum (Hedw.) Dixon (Magill 1981: 182)
Free State (2828 DA: Perold, Koekemoer & Smook 3007).

Hyophila involuta (Hook.) A.Jaeger (Magill 1981: 228)

- Swaziland (2631 AB: Braun 1719, 2631 AC: Braun 1468).

Syntrichia papillosa (Wilson in Spruce) Jur. (as *Tortula papillosa* in Magill 1981: 218)

- Namibia (2715 BD: Oliver 10208).

Timmiella pelindaba Magill (Magill 1981: 253)

- Eastern Transvaal (2530 BC: Anderson CH13585).

Trichostomum tenuirostre (Hook. & Taylor) Lindb. (as *Oxystegus cylindricus* in Magill 1981: 259)

- Eastern Transvaal (2530 BC: Burrows 5983).

BRYACEAE

Brachymenium nepalense Hook.in Schwägr. (Magill 1987: 347)

- Swaziland (2631 AA: Veltman 111).

Bryum

- canariense Brid. (Magill 1987: 381)
Swaziland (2631 AB: Smook 8935a).
- capillare Hedw. (Magill 1987: 372)
Southern Transvaal (2628 CA: Glen 2513)
- cellulare Hook. (Magill 1987: 363)
Swaziland (2631 AA: Braun 1714).

BARTRAMIACEAE

Philonotis africana (C.Müll.) Paris (Magill 1987: 429)

- Southern Cape (3322 DC: Koekemoer 1000).

ERPODIAEAE

Erpodium beccarii C.Müll. (Van Rooy 1993: 35)

- Swaziland (2631 BB: Braun 767).

PTYCHOMITRIACEAE

Ptychomitrium eurybasis Dixon (Van Rooy 1993: 35)

- Free State (2828 DB: Magill 6604).

ORTHOTRICHACEAE

Orthotrichum rupestre Schwägr. (Van Rooy 1993: 36)

- KwaZulu-Natal (2929 CB: Magill 7052).

HEDWIGIACEAE

Braunia secunda (Hook.) Bruch, Schimp. & W.Gümbel (Van Rooy 1993: 37)

- Free State (3027 AC: Van Rooy 2545).

THUIDIACEAE

Haplohymenium pseudotriste (C.Müll.) Broth. (Van Rooy 1993: 42)

- Swaziland (2631 AA: Glen 3114).

HYPNACEAE

Vesicularia galerulata (Duby) Broth. (Van Rooy 1993: 45)

- Namibia (2017 AD: Volk 1117).

POLYTRICHACEAE

Atrichum androgynum (C.Müll.) A.Jaeger (Van Rooy 1993: 46)
Swaziland (2631 AB: Smook 8912).

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I would like to thank all the collectors of bryophytes in southern Africa for their contribution to bryology.

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J. VAN ROOY*

* National Botanical Institute, Private Bag X101, 0001 Pretoria.
MS received: 1997-02-06.

METZGERIALES–FOSSOMBRONACEAE

THE LECTOTYPIFICATION OF *FOSSOMBRONIA CRISPA*

In the protologue of *F. crispa* Nees in Gottsche *et al.* (1844–1847), the second species of the genus to be described from southern Africa, the following is stated: ‘foliis subhorizontalibus planiusculis subrotundo-quadratis truncatis integerrimis subrepandis’ (leaves with margins absolutely entire, very slightly uneven and wavy), and in the commentary it is noted that, ‘differt ab affinibus foliis nec lobatis neque dentatis’ (differs from the allies in the leaves being neither lobed nor dentate). The following synonyms are given: *Jungermannia crispa* Spreng. in sched. Herb. Zeyher, and *J. pusilla* Lehm. Hep. Cap. Ecklon in Linn. 4: 369, No. 42. [presumably in the sense of Lehmann, since Linnaeus (1753) is the author of this taxon]. The locality is stated to be ‘In Promontorio Bonae Spei, locis umbrosis ad latus orientale montis Tabularis et in locis humidis prope hortos

eiusdem montis’. It is also noted that ‘Octobri cum fructibus (Ecklon in Hb. Zeyher, N. et L.)’. This Ecklon holotype in Hb. Zeyher has not been traced. In the absence of a holotype, Article 9.9 of the ICBN (Greuter *et al.* 1994) permits the designation of a lectotype chosen from the original material. I propose to do this in the following paragraph.

Acting on the advice of Dr R.Grolle, who kindly refereed an earlier draft of this note, the *F. crispa* specimens seen by Nees were requested on loan from STR and graciously sent by the curator. Of the five specimens sent, only one (numbered 3 in pencil) has spores; the ornamentation is incompletely reticulate (Figure 4A, B), and the margins of the leaves are entire. This specimen (Figure 5) is here selected as the lectotype of *F. crispa*.

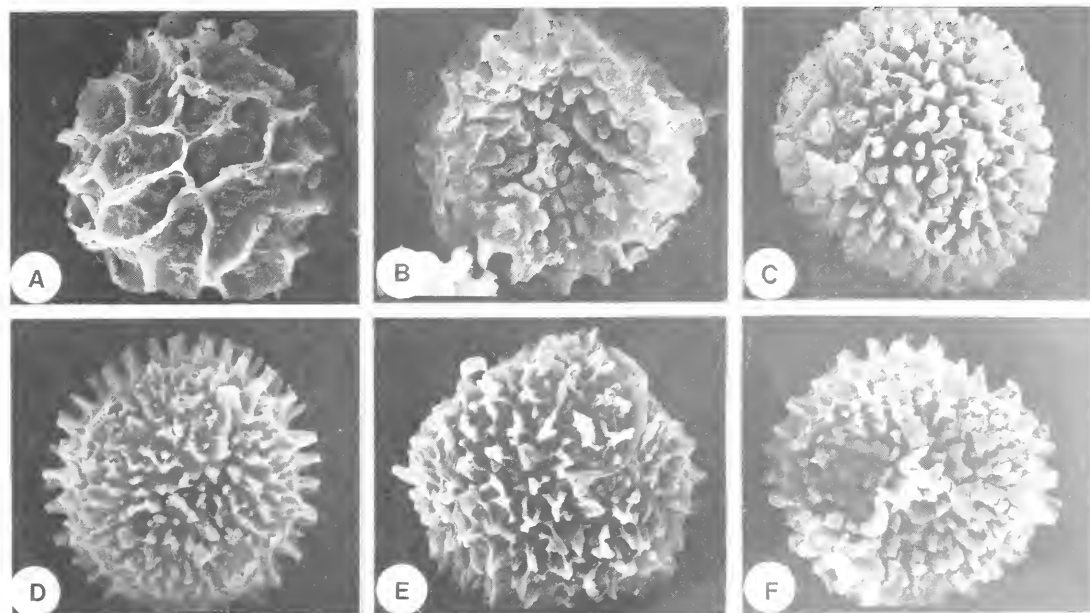


FIGURE 4.—*Fossombronia* spores. *F. crispa*: A, distal face; B, proximal face. *F. leucoxantha* (non *F. crispa*): C, distal face, D, proximal face. *F. leucoxantha* (lectotype in S): E, distal face; F, proximal face. A, B, Zeyher (STR), lectotype; C, D, Ecklon 64 (BM); E, F, Ecklon L.29 (S), lectotype. A, $\times 906$; B, $\times 940$; C, $\times 713$; D, $\times 701$; E, $\times 975$; F, $\times 848$.

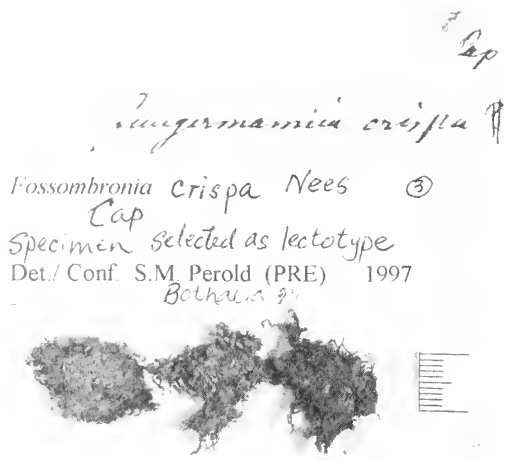


FIGURE 5.—Photograph of *Fossombronia crispa* packet and portion of specimen held at STR.

There is no collector's name on the packet, however. A specimen (Figure 6D), which is presumably a duplicate, since the label is in the same handwriting, is mounted on a herbarium sheet held at BM (ex Herb. Hampe 1881). It would appear that the epithet, *F. crispa*, has since Stephani (1900) been wrongly applied to plants with dentate leaves and spinose spores (i.e. *F. leucoxantha*) and not to plants with entire leaves and reticulate spores.

There are six liverwort collections pasted on the said herbarium sheet in BM, in two rows of three each, one below the other (Figure 6A–F). Scott & Pike (1987) numbered these specimens 1:1 (Figure 6A), up to 1:6 (6F). All

specimens except 1:5 (6E) are labelled *Jungermannia* (or *Fossombronia*) *crispa*. Specimens 6A, B and D have leaves with entire margins and incompletely reticulate spores. The five small pieces under 6C have dentate leaves and spinose spores. Specimen 6E is labelled *J. pusilla*, and 'No. 42' has been added to the label in pencil. It consists of a mixture of two different species of *Fossombronia*; they are both sterile and could therefore not be identified to species level. This specimen was originally referred to in *Hepaticarum capensium* (Lehmann 1829), where it is remarked that it was collected with fruit in October. As stated above, it was cited by Nees under synonymy of *F. crispa*. Specimen 6F is not a *Fossombronia*. It could be a *Riccardia* and need not be considered further.

A duplicate of one of the specimens with entire leaf margins and incompletely reticulate spores (Figure 6A, B or D) was described by Stephani (1900) as a new species, *F. zeyheri* sub *F. crispa* Spreng. He selected the specimens, leg. Carl Zeyher, previously held at Herb. Rabenhorst (G024669) and at Herb. I(?)ope (first letter illegible) (G024670) as 'original' and rewrote the labels in his own hand. Both these specimens are now housed in G (from whence the herbarium numbers). He was followed in his treatment by Sim (1926), Arnell (1963), Sérgio (1985) and Scott & Pike (1988). Scott & Pike (1988) misidentified the collections on the BM sheet with incompletely reticulate spores (6A, B, D) as *F. pusilla* and the duplicate of one of them (6B) in S (as well as several other specimens) as *F. capensis* Arnell.

Fossombronia zeyheri Steph. is considered to be identical to the earlier *F. crispa* and is hereby placed in synonymy under *F. crispa* Nees. Scott & Pike (1988) cited

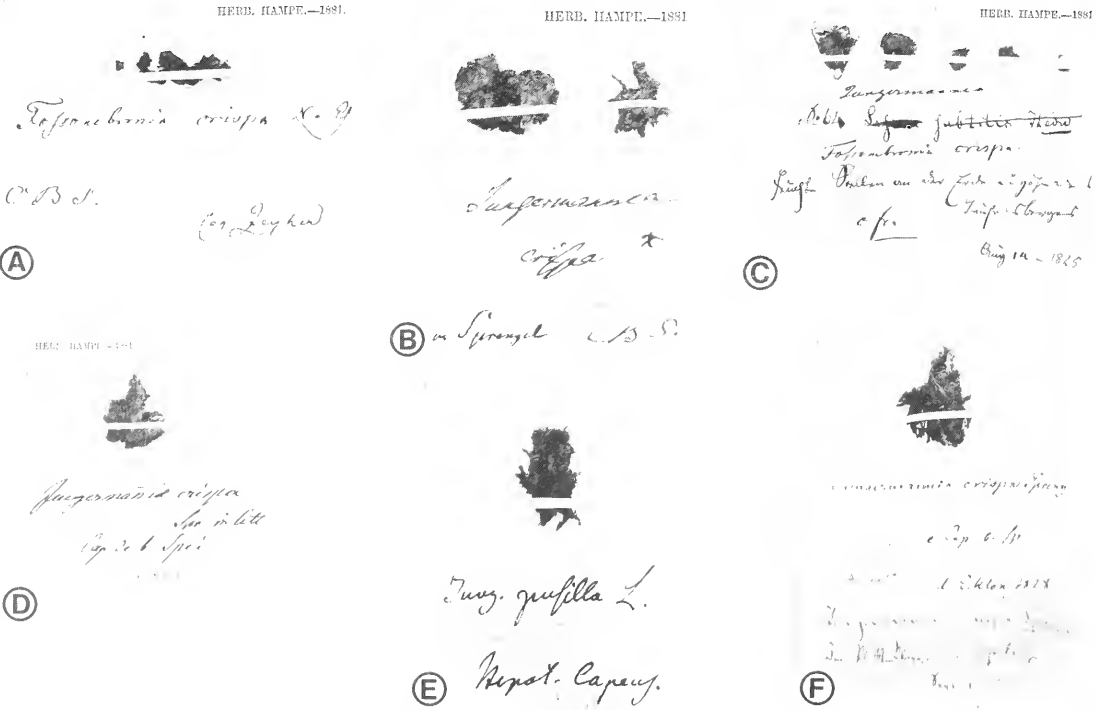


FIGURE 6.—Photograph of herbarium sheet of *Fossombronia crispa* ex Herb. Hampe 1881 held at BM.

specimen 1:3 (6C) on the said BM sheet as the type of *F. crispa*, even though it has dentate leaves and spinose spores. It was most probably collected by Ecklon, but it could not be ascertained which collection series the number 64 on the label refers to. Gunn & Codd (1981) remark that 'it may be difficult to determine whether a given specimen is collected by Ecklon, Zeyher, or both, or whether it is part of a type gathering or not'. The original plant name on the label, '*S. ... subtilis*' Hedw. (the genus name is illegible), has been scored through and *Jungermannia* is written above it and below it *Fossombronia crispa*. Details of the collection site and date are as follows, 'Feuchte Stellen an der Erde, 2^e Höhe des Teufelsberges', 'cfr.' and the date 'Aug. 14, 1825' were added. In a footnote in Lehmann (1829: 358), reference is made to 'die zweite (Höhe) oder die Region der Silberbäume (*Leucadendron argenteum*) bis zu 1000 Fuss' (i.e. above 500 feet; the 'erste Höhe' being below 500 feet). As mentioned before, since Stephani (1900) the epithet *F. crispa* has been wrongly applied to specimen 6C and others like it. Stephani did not explicitly mention the leaf margins, but the spinose spores are described by him as 'papillis longiusculis confertis hispidissimae' (very hispid with longish crowded papillae). He cited an Ecklon specimen (apparently specimen 6C); a MacOwan collection (G024668) (evidently misnamed since it has entire leaf margins and is sterile); and a specimen of *Breutel* (G024665) from Genadendal, which has spinose spores and dentate leaves. Sim (1926) described the leaf margins of *F. crispa* as 'not dentate, the lower margin usually inflexed'. Some sterile Sim specimens at PRE, 7582 & 8024, have initially been identified by him as *F. zeyheri* and later as *F. crispa*, so his concept of the species may not always have been clear. According to Arnell (1963) the leaves of *F. crispa* are usually entire.

In the protologue of *J.* (= *F.*) *leucoxantha* (Lehmann 1829) the following is stated: 'foliis imbricatis horizontalibus subquadrato-rotundis involutis repando-crenatis inciso-dentatisque' (leaves imbricate, horizontal, subquadrate-rotund, rolled inwards, repand-crenulate and incised-dentate). It is stated to grow 'ad latus orientale et boreale montis Tafelberg, ad radicem montis Teufelsberg et in monte Löwenschwanz humi inter arbuscula'. I consider, Ecklon 64 (specimen 6C), collected at Teufelsberg (Devil's Peak), to be a syntype of *F. leucoxantha*.

As already noted by Scott & Pike (1987), Stephani treated *F. leucoxantha* as a tumid-leaved plant (i.e. *F. tumida* Mitt.), because he studied a mixed collection of

these two species. The specimens he examined lacked spores, therefore he was unaware that the true *F. leucoxantha* (with incised dentate leaves) has spinose spores. My SEM micrographs of the spore ornamentation of the specimen Ecklon L.29 (S) (Figure 5E, F), are slightly different from those published by Scott & Pike (1987), who selected it as the lectotype of *F. leucoxantha*, but they are nevertheless still within the acceptable range of variation in spore ornamentation for this species.

ACKNOWLEDGEMENTS

I sincerely thank Dr R. Grolle, Jena, for drawing my attention to the fact that Nees' herbarium is held at STR and for his helpful advice and constructive criticism; Dr D.J.B. Killick, retired Deputy Director, BRI, as well as my colleagues at NBI, Dr H.F. Glen, Dr O.A. Leistner and Mr J. van Rooy for profitable discussions and advice. Dr P. Geissler, Geneva, is thanked for her investigations on my behalf and for the loan of specimens. The curators of BM, S and STR are also thanked for the loan of specimens.

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S.M. PEROLD*

* National Botanical Institute, Private Bag X101, Pretoria 0001.
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PORTULACACEAE

PORTULACA RHODESIANA, A SUCCULENT HITHERTO UNRECORDED IN SOUTHERN AFRICA

A miniature, mat-forming species of Portulacaceae was unexpectedly collected by EJvJ during a field trip undertaken in April 1996 to re-collect *Crassula cymbiformis* Toelken at Groothoek in the extreme western part of the Waterberg, Northern Province (Figure 7). Plants grew in association with the poikilohydric resurrection

plant, *Myrothamnus flabellifolius* Welw. EJvJ subsequently identified the portulacaceous specimen at the National Herbarium (PRE), Pretoria, as *Portulaca rhodesiana* R.A.Dyer & E.A.Bruce (1949). Plants were found in shallow, gravel-filled pockets in sandstone and conglomerate of the Alma Formation, Waterberg Group.

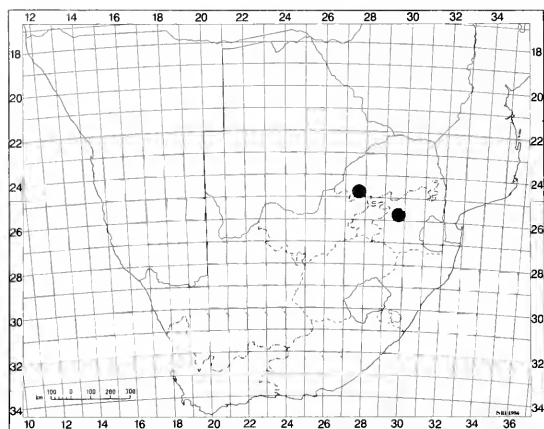


FIGURE 7.—Known distribution of *Portulaca rhodesiana* in South Africa.

Plants collected by EJvJ are kept in the living collection of GFS and at the Kirstenbosch National Botanical Garden, whence they will be distributed to other botanical gardens of the National Botanical Institute. This new collection (*E.J. van Jaarsveld 15051*) represents a significant southward expansion of the distribution of the species. It had previously been known only from Zimbabwe, with the southernmost record from the Matopo Hills where it grows as a pioneer on granite outcrops (Dyer & Bruce 1949; Wild 1961).

More recently three of the authors (all except EJvJ) collected the species near Middelburg, Mpumalanga, where it had been observed by ST some years ago (Figure 7). The identity of this specimen, too, was confirmed as *P. rhodesiana*, by Mrs Marie Jordaan of PRE. The occurrence of this species at this locality represents a further significant southeasterly extension of its known distribution range.

These collections came at an opportune time since they complement the list of succulent portulacas being compiled by M. Jordaan for the *List of southern Africa succulent plants* project, a joint effort of the National Botanical Institute and the Succulent Society of South Africa.

The species is a true miniature of the genus, mature sterile plants hardly exceeding a height of 10 mm. It is therefore not surprising that it has not been recorded for southern Africa before. The habitat of the species near Middelburg is seasonally wet, shallow soil pockets on red porphyritic rhyolite of the Selons River Formation, Rooiberg Group. The surrounding vegetation is grassland, which has been significantly transformed by grazing cattle. At both localities plants grew in fully exposed, sunny places.

The entry for the species in the taxon component of PRECIS is as follows:

2421000-12# *Portulaca rhodesiana* R.A.Dyer & E.A.Bruce in *The Flowering Plants of Africa* 27: t. 1069 (1949). Type: Zimbabwe, 67 km east of Salisbury (now Harare), *Eyles 8821* (K, holo., photocopy!).

Specimens examined

NORTHERN PROVINCE.—2427 (Thabazimbi): Rankin's Pass, 25 km from Alma on road to Thabazimbi, via Bakker Pass, in gravel-filled holes, on flat outcrops of rock on top of mountain. Petals white, (–DB), *E.J. van Jaarsveld 15051* (PRE).

MPUMALANGA.—2529 (Witbank): pan, 6 km from Middelburg on road to Hendrina, eastern side of road, ± 30 m from fence line, on flat rock outcrops which are seasonally flooded. Petals pinkish white, opening in hot, overcast weather, (–DC), *G.F. Smith 252* (PRE).

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G.F. SMITH*, E.J. VAN JAARSVELD**, B-E. VAN WYK*** and S. TAYLOR†

* Research Directorate, National Botanical Institute, Private Bag X101, Pretoria 0001.

** Kirstenbosch National Botanical Garden, National Botanical Institute, Private Bag X7, Claremont, 7735 Cape Town.

*** Department of Botany, Rand Afrikaans University, P.O. Box 524, Auckland Park, 2006 Johannesburg.

† 26 Sonneblom Street, Northmead, 1501 Benoni.

MS. received: 1997-02-19.

See Germishuizen (1997: *Bothalia* 27: 146).

CAMPANULACEAE

VALID PUBLICATION OF WAHLENBERGIA UITENHAGENSIS VAR. DEBILIS

In a note in *Bothalia* 26: 157 (1996), the new combination *Wahlenbergia uitenhagensis* var. *debilis* was not validly published, as the basionym was not cited. This is now corrected.

***Wahlenbergia uitenhagensis* (H.Buck) Lammers var. *debilis* (Sond.) W.G.Welman comb. nov.**

Lightfootia ciliata (Thunb.) Sond. var. *debilis* Sond.: 561 (1865). Holotype: Uitenhage, Winterhoek, *Zeyher 3131* (S).

L. divaricata H.Buck var. *debilis* (Sond.) Adamson: 182 (1955). Type as above.

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W.G.WELMAN*

* National Botanical Institute, Private Bag X101, Pretoria 0001. MS received: 1997-03-26.

CONVOLVULACEAE

TWO EXOTIC TAXA OF *IPOMOEA* AND *MERREMIA* IN SOUTHERN AFRICA

Recently two exotic taxa of the Convolvulaceae occurring in southern Africa, attracted some attention.

***Ipomoea carnea* Jacq. subsp. *fistulosa* (Mart. ex Choisy) D.Austin**

I. fistulosa Mart. ex Choisy

I. crassicaulis (Benth.) Robinson

This pantropical weed has been recorded as poisonous to goats in India, the Sudan, Tanzania and now also in Mozambique (Prof. em. T.W. Naudé pers. comm.). *I. carnea* belongs to the section *Eriospermum* Hallier f. of *Ipomoea* L. together with *I. arborescens* G.Don which is often cultivated in southern Africa.

Description: erect to scrambling shrubs to 3 m high; stems woody at base, herbaceous at tips, hollow, glabrous or minutely pubescent. *Leaves* alternate, entire, ovate to lanceolate, 100–250 mm long, truncate to shallowly cordate at base, long acuminate apically, pubescent on both sides but sometimes glabrescent; petioles 20–100 mm long. *Flowers* in cymose-paniculate clusters at branch tips, 1- to several-flowered; sepals 5, suborbicular, 5–6 mm long, somewhat unequal, subcoriaceous, glabrous or pubescent, persistent; corollas funnel-shaped, 5-lobed, deep pink to rose-purple, throat darker than limb, 50–90 mm long, finely tomentose outside, midpetaline areas well defined; stamens 5. *Fruit* a capsule, ovoid to subglobose, 20 × 10–15 mm, glabrous. *Seeds* usually 4, covered with long comose brown trichomes.

The subsp. *fistulosa* is distinguished by lanceolate to ovate leaves whereas the subsp. *carnea* has cordate to rounded leaves.

Distribution: *I. carnea*, with two subspecies, is of tropical American origin. The subsp. *carnea* seems to be confined to its natural distribution area from Peru to Mexico. The subsp. *fistulosa*, however, with a natural distribution area from Argentina to Florida and Texas, has been introduced to the tropics of the Old World and Hawaii, where it has often escaped from cultivation. In southern Africa it is found in Mozambique, the Northern Province, Mpumalanga, KwaZulu-Natal and probably also in Swaziland. PRE has specimens from 2530BD, 2732CA, 2732CC, 2830CA, 2832AD, 2930DB, 3030AD [expressed in terms of the Degree Reference System (Edwards & Leistner 1971)].

Ecology: *I. carnea* flowers throughout the year. The subsp. *carnea* prefers dry habitats whereas the subsp. *fistulosa* prefers wet habitats. In southern Africa *I. carnea* subsp. *fistulosa* is suberect and grows in open, sunny sites, often climbing in shaded areas. It is cultivated as an ornamental as well as in hedges and windbreaks and often occurs as culture relic and escape from cultivation. It will then occur in disturbed areas such as along roadsides, but also in grassland, along river banks and in other moist areas. *C.J. Ward 12368* (PRE, UDW), collected

below the Inanda Dam wall in KwaZulu-Natal in August 1993, appears to have become naturalized.

***Merremia dissecta* (Jacq.) Hallier f.**

Ross: 295 (1972) listed this species for Natal (KwaZulu-Natal) with the voucher *Schweickerdt 1361* (NH) from an unknown locality. In this way the name *M. dissecta* became connected with the indigenous southern African flora. It was listed as 'Endemic' and 'Rare' for KwaZulu-Natal, and with its global conservation status also 'Rare', by C.Hilton-Taylor in *Red Data List of southern African plants*: 74 (1996).

The label of the cited specimen, *Schweickerdt 1361*, however, states that it was cultivated in the Durban Botanical Garden, flowering in May 1939. Another specimen in NH and PRE, *C.N. Buthelezi 636*, was flowering and fruiting in January 1986, and was growing in the Natal Herbarium Garden, which adjoins the Durban Botanical Garden. It seems that there are no further records in NH or in PRE of this taxon, either cultivated or as garden escapes.

Description: *M. dissecta* is a perennial twiner, coarsely hirsute at first, becoming almost glabrous (petioles, peduncles and young stems with long patent yellowish hairs ± 4 mm long). *Leaves* deeply palmately 5–7-fid, lobes lanceolate, up to 100 mm long, coarsely sinuately dentate, middle lobe larger than lateral ones. *Corolla* white, up to 35 mm long, with purple or dull reddish throat. *Capsule* globose, ± 15 mm across, surrounded by enlarged brownish sepals.

Distribution and ecology: native to the southern United States of America and south to Argentina. Occasionally it escapes from cultivation in tropical regions, Bailey & Bailey: 729 (1977).

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W.G.WELMAN*

* National Botanical Institute, Private Bag X101, 0001 Pretoria.
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ERICACEAE

A NEW SPECIES OF *ERICA* FROM THE WESTERN CAPE

***Erica magnisylvae* E.G.H.Oliv.** sp. nov., *E. arenariae* L. Bolus propter pilos ramorum plumosos, flores albos parvos, antheras similes calcaribus parvis, pollinationem vento affinis, sed habitu ad 3 m alta, pedicello breviori, lobis corollae incurvis, antheris inclusis filamentis brevibus, stigmate manifesto peltato-cyathiformi albo dignoscenda. Figura 8.

TYPE.—Western Cape, 3419, Gansbaai area, Baviaansfontein [Grootbos], hills due west of Swartkransberg [Beacon 3], S-facing slopes, 1200 ft, (–CB), 17 April 1997, *Oliver & Lutzeyer 10788* (NBG, holo.; BM, BOL, E, G, K, MEL, MO, NY, P, PRE, S, W).

Shrub erect, slender, up to 3 m high, single-stemmed reseeded. *Branches:* several main branches fast growing, 150–300 mm long within a year, continuing vegetative growth apically, numerous secondary branches 10–100

mm long at each node of main branch, numerous tertiary branchlets 2–5 mm long, secondary and tertiary branches ending in a florescence; all with short simple hairs and numerous plumose longer hairs ± 0.2 mm long. *Leaves* 3-nate, spreading, $2.0\text{--}2.7 \times 0.7$ mm, lanceolate, adaxially flattened, abaxially rounded and narrowly sulcate, with margins acute, ciliate towards base with simple or occasionally plumose hairs, otherwise glabrous; petiole appressed, 0.5 mm long, ciliate. *Inflorescence:* flowers 3-nate in 1(2) whorls, terminal on most secondary and tertiary branches; spreading to subpendulous; *pedicel* 1 mm long, with simple and plumose hairs, pale greenish white; *bract* partially recalcrescent and subapproximate to calyx, 0.9×0.7 mm, elliptic-lanceolate, glabrous, shortly ciliate, narrowly sulcate in upper half, pale green with dark green sulcate apical portion and white lateral zones; *bracteoles* 2, approximate to calyx, 0.9×0.6 mm, elliptic, otherwise like bract. *Calyx* 4-partite; lobes im-

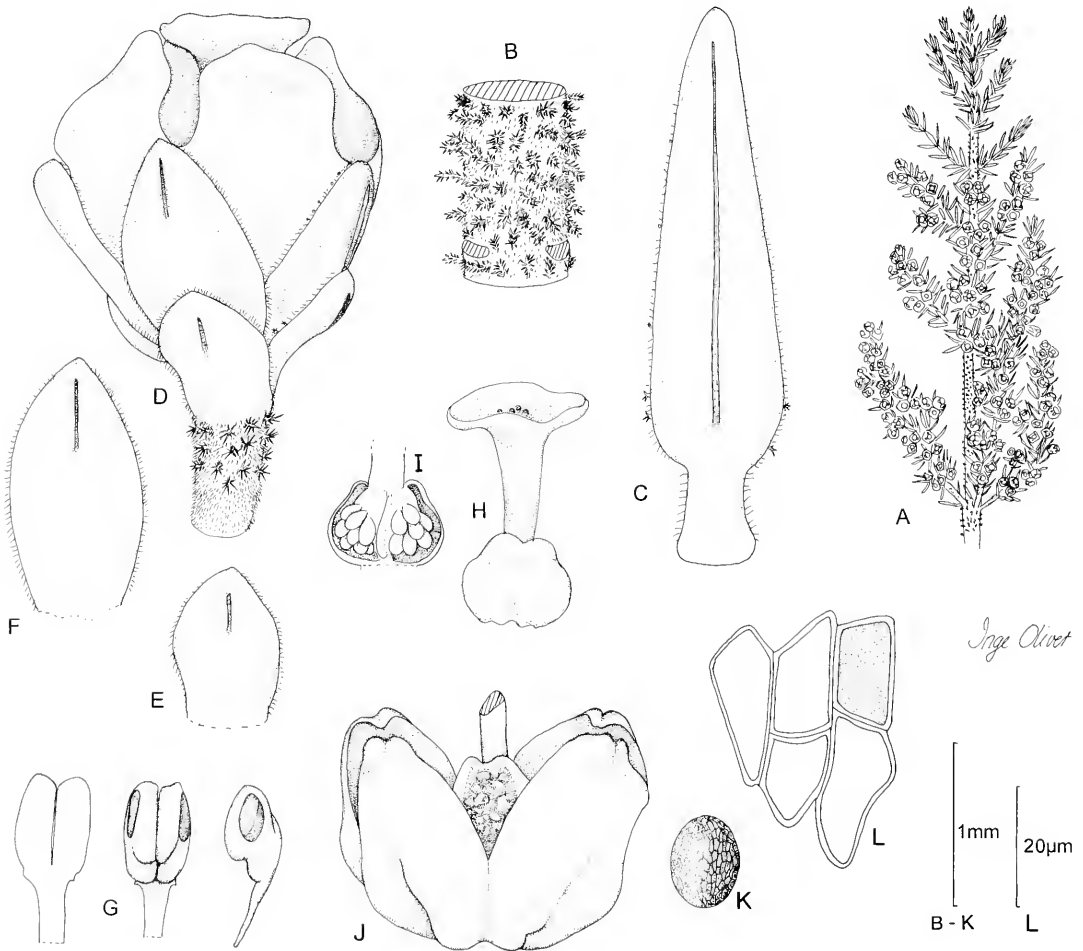


FIGURE 8.—*Erica magnisylvae* E.G.H.Oliv.: A, flowering branch; B, stem; C, leaf; D, flower; E, bract; F, sepal; G, stamen; H, gynoecium; I, ovary, opened laterally; J, capsule; K, seed; L, testa cells, with one cell showing pits. All drawn from the type collection, *Oliver & Lutzeyer 10788*. A, $\times 0.5$. Scale bars: B–K, 1 mm; L, 20 μ m.

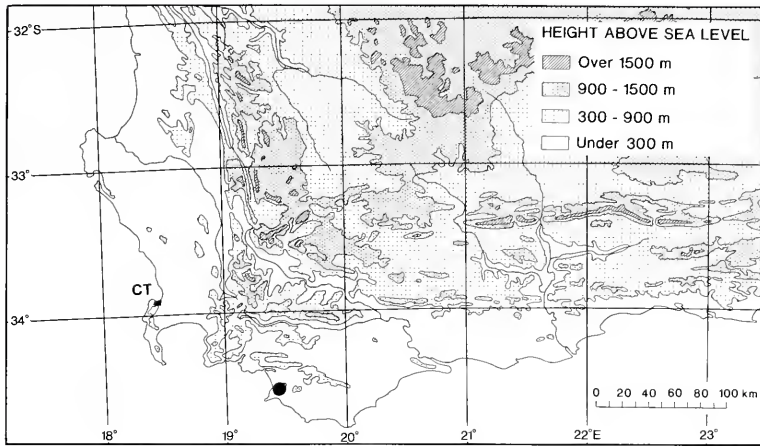


FIGURE 9.—Known distribution of *Erica magnisylvae* E.G.H.Oliv.

bricate, adpressed to calyx, 1.5×0.8 mm, elliptic, glabrous to shortly ciliate, sometimes also with a few small sessile non-sticky glands, colour as in bract but with larger lateral white zones. *Corolla* 4-lobed, 1.6×1.6 mm, ovoid to ovoid-urceolate, with zone between calyx segments bulging outwards, glabrous, smooth, white; lobes 0.8×0.9 mm, broadly triangular, obtuse, entire, bent inwards towards style with slightly recurved margins and elongate-ovate gap between lobes. *Stamens* 8, free, included; *filaments* 0.4 mm long, rectangular, erect, straight, with or without minute lateral spurs below anther, white basally and brown apically; *anthers* bilobed, elliptic, erect, brown, mucous [but see filament]; thecae appressed, 0.6×0.4 mm, narrowly elliptic, glabrous; pore $\frac{1}{2}$ length of theca; *pollen* in tetrads. *Ovary* 4-locular, 0.5×0.7 mm, ovoid, slightly emarginate, glabrous or with a few simple apical hairs, green; nectaries absent; *ovules* 4–7 per locule, pendulous to spreading from placenta covering most of columella; *style* 0.6 mm long, cylindric, erect, straight, glabrous, white; *stigma* peltate-cyathiform, manifest or just above corolla lobes, greenish white sometimes with pinkish tinge, with 4 central reddish stigmatic knobs. *Fruit* a dehiscent capsule, $\pm 2.8 \times 3.8$ mm, cyathiform, valves splitting for $\frac{2}{3}$ their length, septa with 50% portion on valve thick and other 50% portion on columella thin, placenta flattened and indistinct with only seed attachment points visible; *seeds* 0.5×0.4 mm, ovoid to ellipsoid, slightly reticulate, shiny, yellow-brown, testa thin with cells slightly sunken, $\pm 20\text{--}25 \times 15$ μm , slightly longer than broad with straight, slightly thickened anticlinal walls and numerous small pits. Figure 8.

Erica magnisylvae is most similar to *E. arenaria* L.Bolus, which also has an erect habit, but grows only to 1.5 m high, has the same type of plumose hairs on branches and pedicels, small white flowers with similarly shaped anthers with minute spurs and also a wind-pollination syndrome. The new species may easily be distinguished by the shorter pedicel ($\pm \frac{1}{2}$ as long as in *E. arenaria*), the corolla lobes incurved with ovate sinuses (not erect to outcurved with acute sinuses), the well included anthers (not manifest to subexserted), the filaments equal to or shorter than the anthers (not noticeably longer than the anthers), the shorter style about equal to ovary (not $4 \times$ the length of the ovary), and the larger

peltate-cyathiform manifest stigma (not small and well exserted).

E. arenaria is confined to the calcrete ridges near the coast between Still Bay and the mouth of the Breede River some 70 km to the east of the known locality of *E. magnisylvae*. An unusual form of the former species has been recorded from the hills near De Hoop (Oliver 8447), but needs further study to assess its taxonomic status with respect to typical *E. arenaria* and *E. magnisylvae*.

There are a number of species in the genus which possess distinctive plumose hairs. These species are spread throughout the whole genus and its geographical range, including tropical Africa. In certain cases there are clear indications of species alliances sharing this character, but there are also cases where the plumose hairs are found in totally unrelated species thus leading to the hypothesis of convergent evolution.

The first record of this new species was made by S. Privet, the resident ecologist at the Grootbos Nature Reserve which is owned and run by the Lutzeyer family who brought material to us for identification. Their reserve is being developed for ecotourism, hence the interest in the vegetation and flora.

E. magnisylvae is a restricted endemic known thus far only from the hills just inland from the main road between Gansbaai and Stanford (Figure 9). The hills fall within the farm labelled as Baviaans Fonteyn [Baviaansfontein] on the 1 : 50 000 trigonometrical survey maps, but known locally as the Grootbos Nature Reserve, hence the name [*magnus* = large, great; *sylva* (or *silva* in classical Latin) = wood, forest; *magnisylvae* = of the large forest]. The hills start at Swartkransberg (labelled Beacon 3) and run due west for about 2.5 km. There the species occurs on southern to southwestern slopes mainly in deep brownish grey sand, apparently wind-blown, overlying calcrete deposits which have many sandstone intrusions.

The type population on the westernmost hill, where the plants are locally common, occurs on a fairly steep south-facing slope in vegetation that is mostly of the coastal fynbos type with some elements of strandveld

vegetation intermixed. The vegetation is dominated by large shrubs of *Leucadendron coniferum* (Proteaceae) which is known to prefer habitats of wind-blown sand (A.G. Rebelo pers. comm.) and *Leucospermum pater-sonii* and numerous plants of *Metastasia muricata*. The large size of the proteads and the *Erica* are the result of a long period without any burning. No records are available to pinpoint the date of the last fire, but from the proteads it is possible to estimate an age of about 25 years for the vegetation. Smaller scattered populations occur eastwards towards Swartkransberg where another large population occurs. This grows on a west-facing slope on sandstone covered by mountain fynbos vegetation which includes *Protea cynaroides*.

The old plants were clearly single-stemmed with only the ultimate branches being leafy. Seedlings were noted in the disturbed areas along tracks in the area. Parts of a nearby slope that had been burnt several years ago contained numerous vigorously growing young plants 1 m high.

The pollination syndrome of the species is deduced to be anemophily due to the lack of nectaries, to the enlarged, manifest, peltate-cyathiform stigma complex and

the reduced size of the flowers (Oliver 1991; Rebelo *et al.* 1985). When the populations were visited, the weather was overcast and misty so that no shedding of pollen was possible. However, material brought back to the herbarium for detailed study and placed in vases shed puffs of pollen when the specimens were disturbed the following morning, thus simulating the field situation. Flowering period is from March to May.

WESTERN CAPE.—3419: Grootbos near Gansbaai, 1200 ft. (–CB), 13-04-1997, *Privet & Lutzeyer s.n.* (NBG, paratype).

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E.G.H. OLIVER* & I.M. OLIVER*

* Compton Herbarium, National Botanical Institute, Private Bag X7, 7735 Claremont, Cape Town.
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NEW RECORDS OF FLOWERING PLANTS FOR SWAZILAND

Two field trips were undertaken by the author to Swaziland, one during March 1993 and the next during January 1994. The purpose of these trips were threefold, namely, for herbarium expansion, secondly as part of the National Plant Collecting Programme, a project of the National Botanical Institute to collect in undercollected sites throughout southern Africa, and thirdly to make an inventory of plant species growing in a proposed dam site.

During March 1993 the first collections were made at the old and new Nkomati bridges, 20 kilometers south of Pigg's Peak on the road to Mbabane in the 2631AA quarter degree grid and the second on the north bank of the Nkomati River, east of the Mhlatane River in the 2631AB quarter degree grid. During January 1994 the Masilela and the Malandzela areas, on the Maphalaleni road in the 2631AB quarter degree grid, were visited. On both these visits the following new and interesting records were found.

Bulbostylis barbata (Rottb.) C.B. Clarke (Figure 10, Table 1), is a new record for the *Flora of southern Africa* region. This species is widespread especially in the southern hemisphere. Voucher specimens of *B. barbata* from Zimbabwe, Kenya, Burundi and Ghana are housed at the National Herbarium (PRE).

Table 2 lists plant species collected on both field trips not accounted for in the *Flora of Swaziland* (Compton 1976) and does not include any of the taxa mentioned in Table 1.



FIGURE 10.—Herbarium specimen of *Bulbostylis barbata* (Rottb.) C.B. Clarke, *G. Germishuizen* 6174 (PRE).

TABLE 1.—List of plant taxa found in Swaziland and not previously recorded in PRECIS at the National Herbarium, Pretoria. Vouchers: G. Germishuizen.
† Germishuizen 1997: 146

Genspec No.†	Taxon	Grid	Voucher	Previously known from*
0471010-1	<i>Bulbostylis barbata</i> (Rottb.) C.B.Clarke	2631AB	6174	Trop. Afr.
4726000-3	<i>Cardiospermum grandiflorum</i> Sw. var. <i>hirsutum</i> (Willd.) Radlk.	2631AA	6004	EC; G; KN; M; N
0990000-4	<i>Chlorophytum aridum</i> Oberm.	2631AA	5978	nKN; M; NP
2574000-4	<i>Cissampelos hirta</i> Klotzsch	2631AB	7229	KN
8598000-2	<i>Citrullus lanatus</i> (Thunb.) Matsum. & Nakai	2631AA	6098	Throughout FSA
3898000-60	<i>Eriosema transvaalense</i> C.H.Stirt.	2631AB	7029; 7248	M; NP
7365000-22	<i>Hemizygia petiolata</i> M.Ashby	2631AA	5982	NP
3702030-10	<i>Ludwigia parviflorum</i> (B.Heyne ex Wight & Arn.) Schrire var. <i>parviflorum</i>	2631AB	6123	Throughout FSA
2376000-46	<i>Limnium viscosum</i> (J.Gay) Fenzl subsp. <i>viscosum</i> var. <i>glomeratum</i> (Eckl. & Zeyh.) Friedrich	2631AA	6049	FS; G; M; NWP
5793000-4	<i>Ludwigia octovalvis</i> (Jacq.) P.H.Raven subsp. <i>sessiliflora</i> (Micheli) P.H.Raven	2631AA	6009	EC,WC, NC; KN; M; NWP
0128000-4	<i>Mohria nudiuscula</i> J.P.Roux	2631AB	7191	Throughout FSA
6787010-14	<i>Pachycarpus grandiflorus</i> (L.f.) E.Mey. var. <i>tomentosus</i> (Schltr.) N.E.Br.	2631AB	6180	KN; M
4299000-21	<i>Phyllanthus myrtaceus</i> Sond.	2631AB	6191	EC; KN
4273000-84	<i>Polygala producta</i> N.E.Br.	2631AA; AB	5927; 6161	M; KN
6778000-24	<i>Schizoglossum bidens</i> E.Mey. subsp. <i>pachyglossum</i> (Schltr.) Kupicha	2631AA	5968	FS; KN; M
6481000-30	<i>Sebaea hymenosepala</i> Gilg	2631AB	7218	s & EC
7568000-63	<i>Selago elongata</i> Hilliard	2631AB	7203	nKN
3536020-3	<i>Senna didymobotrya</i> (Fresen.) Irwin & Barneby	2631AA	6010	KN; N; NP
3718000-132	<i>Tephrosia villosa</i> (L.) Pers. subsp. <i>elrenbergiana</i> (Schweinf.) Brummitt	2631AA	6083	G; M; N; NP; NWP
0183100-11	<i>Thelypteris pozoi</i> (Lag.) Morton	2631AA	6045	E, s & WC; KN; M; NP
2118000-28	<i>Thesium cornigerum</i> A.W.Hill	2631AA	5925	KN
2118000-77	<i>Thesium gracile</i> A.W.Hill	2631AA	5992	NP
2118000-119	<i>Thesium multiramulosum</i> Pilg.	2631AA	6035	G; M; NP; KN
8668000-1	<i>Waltherbergia abyssinica</i> (Hochst. ex A.Rich.) Thulin subsp. <i>abyssinica</i>	2631AB	7157	KN

* EC, Eastern Cape; FSA, Flora of southern Africa; FS, Free State; G, Gauteng; KN, KwaZulu-Natal; MP, Mpumalanga; N, Namibia; NC, Northern Cape; NP, Northern Province; NWP, North-West Province; Trop. Afr., Tropical Africa; WC, Western Cape; n, northern; s, southern.

TABLE 2.—List of plant taxa collected in Swaziland and not included in the *Flora of Swaziland* (R.H. Compton 1976). Vouchers: G. Germishuizen.
† Germishuizen 1997: 146

Genspec No.†	Taxon	Grid	Voucher
8795000-2	<i>Ageratum houstonianum</i> Mill.	2631AB	6173
2335000-6	<i>Alternanthera sessilis</i> (L.) DC.	2631AA	6053
0899000-3	<i>Aneilema brunneospermum</i> Faden	2631AA; AB	5953; 6176
0471010-11	<i>Bulbostylis hispidula</i> (Vahl) R.W.Haines	2631AB	6143; 7047; 7189
8541000-13	<i>Cephalaria pungens</i> Szabó	2631AB	6138
3536010-14	<i>Chamaecrista stricta</i> E.Mey.	2631AB	6112
0896000-16	<i>Commelina diffusa</i> Burm.f. subsp. <i>scandens</i> (C.B. Clarke) Oberm.	2631AA	6062
8136070-1	<i>Conostomium natalense</i> (Hochst.) Bremek. var. <i>glabrum</i> Bremek.	2631AB	6105
3168000-210	<i>Crassula lanceolata</i> (Eckl. & Zeyh.) Endl. ex Walp. subsp. <i>lanceolata</i>	2631AB	7180
8599000-33	<i>Cucumis zeyheri</i> Sond.	2631AA	6076
3807000-28	<i>Desmodium tortuosum</i> (Sw.) DC.	2631AA	6075
7780000-2	<i>Dicerocaryum senecioides</i> (Klotzsch) Abels subsp. <i>senecioides</i>	2631AA	5987
9900890-37	<i>Digitaria longiflora</i> (Retz.) Pers.	2631AA	5949A
9282000-1	<i>Flaveria bidentis</i> (L.) Kuntze	2631AB	6115
8435000-1	<i>Galopina aspera</i> (Eckl. & Zeyh.) Walp.	2631AA	5984
1311000-53	<i>Gladiolus densiflorus</i> Baker	2631AB	6100
2338000-1	<i>Gomphrena celosoides</i> Mart.	2631AA	6006
9006000-358	<i>Helichrysum rugulosum</i> Less.	2631AB	7205
3702000-20	<i>Indigofera amittina</i> N.E.Br.	2631AA	5924
3702000-175	<i>Indigofera filipes</i> Benth. ex Harv.	2631AA	5936
3702000-392	<i>Indigofera spicata</i> Forssk. var. <i>spicata</i>	2631AB	6128
6991000-2	<i>Jacquemontia tannifolia</i> (L.) Griseb.	2631AB	6142
8136000-23	<i>Kohautia virgata</i> (Willd.) Bremek.	2631AA; AB	6030; 6190; 7180
1556000-6	<i>Liparis remota</i> J.L.Stewart & Schelpe	2631AB	7192
5793000-5	<i>Ludwigia octovalvis</i> (Jacq.) P.H.Raven subsp. <i>octovalvis</i>	2631AA	5935
3910020-5	<i>Macrotyloma maranguense</i> (Taub.) Verde.	2631AB	6122
0459030-21	<i>Mariscus keniensis</i> (Kük.) Hooper	2631AA	6055
7522010-5	<i>Melanospermum swazicum</i> Hilliard	2631AB	7237
7377000-1	<i>Nicandra physalodes</i> (L.) Gaertn.	2631AA	5958
8136200-16	<i>Oldenlandia corymbosa</i> L. var. <i>caespitosa</i> (Benth.) Verde.	2631AA	5999
1089000-4	<i>Ornithogalum annae-ameliae</i> U. & D.Müll.-Doblies	2631AB	7193; 7249
2204000-18	<i>Oxygonum dregeanum</i> Meisn. subsp. <i>lanceolatum</i> Germish.	2631AB	7035
2455000-1	<i>Polycarpha corymbosa</i> (L.) Lam. var. <i>corymbosa</i>	2631AA	5960
8992050-2	<i>Pseudognaphalium oligandrum</i> (DC.) Hilliard & B.L.Burt	2631AB	7200
4594000-152	<i>Rhus rehmanniana</i> Engl. var. <i>rehmanniana</i>	2631AA	6014
4594000-190	<i>Rhus transvaalensis</i> Engl.	2631AA; AB	6011; 7128
6778000-21	<i>Schizoglossum bidens</i> E.Mey. subsp. <i>galpinii</i> (Schltr.) Kupicha	2631AB	7186
9411000-272	<i>Senecio madagascariensis</i> Poir.	2631AA; AB	6002; 7236; 7246
3536020-18	<i>Senna septemtrionalis</i> (Viv.) Irwin & Barneby	2631AA	6012
7777000-21	<i>Sesamum triphyllum</i> Welw. ex Asch. var. <i>triphyllum</i>	2631AA	5986
9595000-10	<i>Sonchus integrifolius</i> Harv. var. <i>integrifolius</i>	2631AB	7228
9595000-23	<i>Sonchus wilmsii</i> R.E.Fr.	2631AB	6127
8475000-2	<i>Spermacoe natalensis</i> Hochst.	2631AA	6069
8475000-4	<i>Spermacoe senensis</i> (Klotzsch) Hiern	2631AB	6172
7281000-55	<i>Stachys natalensis</i> Hochst. var. <i>natalensis</i>	2631AB	6182; 7022
3718000-15	<i>Tephrosia brummittii</i> Schrire	2631AA; AB	5973; 6148; 7234

In conclusion it can be seen from both the tables that there is still a strong need to collect in Swaziland and secondly that there is a need to update the *Flora of Swaziland*.

ACKNOWLEDGEMENTS

My thanks go to the staff of the National Herbarium for the identifications of the plants and to Adela Romanowski for photographing the voucher specimens.

REVISION OF THE COMPUTERIZED NUMBERING SYSTEM FOR AFRICAN PLANTS

Three articles in this issue of *Bothalia*, namely Smith & Steyn (1997: 135), Smith *et al.* (1997: 139), and Germishuizen (1997: 144) adopt a revised numbering system. Consequently, to avoid confusion until the next edition of PRECIS (National Herbarium, PREtoria Computerized Information System) is published, this explanation is included here. However, there still exists a computer link between the 'old' numbers and the revised numbers for those herbaria making use of the numbering system used in Arnold & De Wet (1993).

The first comprehensive list of southern African plants to be published from PRECIS was the *List of species of southern African plants* (Gibbs Russell *et al.* 1984), comprising a basic inventory of names in current use by PRE. This was followed by a second edition which appeared in two parts and included synonyms and references to recent literature. Part 1 (Gibbs Russell *et al.* 1985) covered the bryophytes, pteridophytes, gymnosperms and monocotyledons. Part 2 (Gibbs Russell *et al.* 1987) covered the dicotyledons. The third publication of this nature, *Plants of southern Africa: names and distribution*, edited by Arnold & De Wet (1993), provided additional regional distribution data based only on the collections in the National Herbarium (PRE).

In all three above-mentioned works the spermatophytes appear in the same sequence as in Dyer (1975, 1976), which in turn follow the numbering of genera by De Dalla Torre & Harms (1958), in accordance with the Engler system. The numbers for the genera are combined with zeros to make up a seven-digit number for sorting by computer. In genera traditionally indicated by letters after the number (e.g. *Senna*, 3536**b**) the letter is replaced by the equivalent number (e.g. *Senna*, 3536**020**). Following the genus name, the species and infraspecific taxa are listed alphabetically, numbered and combined with zeros **before**—omitted in Arnold & De Wet 1993—and **after** the species number to make up a five-digit number; a gap of 100 empty spaces was left between species (Table 3) to allow for new names in their alphabetical position. This space became inadequate in many cases as new species and infraspecific names were added to the list.

These inadequacies, together with the incorporation of the list of tropical African plant names compiled by Lebrun & Stork (1991, 1992) into PRECIS at the begin-

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G. GERMISHUIZEN*

* National Botanical Institute, Private Bag X101, 0001 Pretoria.
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TABLE 3.—Example of a section of the inventory in Arnold & De Wet (1993) and its equivalent in the new numbering system of Arnold & De Wet (1997)

Old numbering system	Revised numbering system
3536020 SENNA Mill.	3536020 SENNA Mill.
200 corymbosa (Lam.) Irwin & Barneby	2 corymbosa (Lam.) Irwin & Barneby
300 didymobotrya (Fresen.) Irwin & Barneby	3 didymobotrya (Fresen.) Irwin & Barneby
400 hirsuta (L.) Irwin & Barneby	4 hirsuta (L.) Irwin & Barneby

ning of 1997, have led to the revision of the existing numbering system for African plants.

In the revised system, the genus numbers remain the same, but all the specific and infraspecific taxon numbers change. The species numbers range from 1 to 999 (e.g. *Senna didymobotrya* (Fresen.) Irwin & Barneby is represented by 3536020-3). Species names newly included automatically receive the next available number and are not in their alphabetical position. In the full species number the genus number is separated from the species part of the number by a hyphen (e.g. the number of *Senna corymbosa* is 3536020-2).

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- G.GERMISHUIZEN*
-
- * National Botanical Institute, Private Bag X101, 0001 Pretoria.

FSA contributions 9: Onagraceae

P. GOLDBLATT* and P.H. RAVEN**

Annual, biennial, or perennial herbs, sometimes aquatic. *Leaves* opposite or alternate, simple, entire or variously lobed; stipules usually present or 0. *Flowers* bisexual, usually regular, mostly solitary and axillary, subtending leaves sometimes greatly reduced or 0. *Sepals* (2–)4–5(–7), lobes valvate, free floral tube present or 0. *Petals* as many as sepals, or 0, caducous. *Stamens* as many or twice as many as sepals; anthers oblong or linear, introrse, versatile. *Ovary* inferior, locules as many as sepals, with 1 to many ovules in each loculus; style single, terete, often thick; stigma entire or deeply lobed. *Fruit* a capsule or nut, often elongated. *Seeds* terete or prismatic-angled, smooth or papillose, with a terminal tuft of hairs in *Epilobium*. *Ancestral basic chromosome number*: x = 11.

Characters not applicable in southern Africa: some shrubs or trees; fruit a berry in *Fuchsia*, widely cultivated as an ornamental in southern Africa; flowers unisexual in some species of *Fuchsia*.

Genera 17, species ± 674, cosmopolitan in tropical and temperate areas, but mostly America. Two genera native in southern Africa, and two more introduced and naturalized. Unless stated otherwise, all cited type specimens were seen by one or both authors.

- 1a Floral tube 0; sepals persistent in fruit after petals have fallen; petals lacking, or if present, yellow *Ludwigia*
- 1b Floral tube present; sepals not persistent in fruit, falling with floral tube; petals yellow, rose-purple, or white:
 - 2a Flower zygomorphic, petals white; fruit nutlike, indehiscent, with 2–8 ovules *Gaura*
 - 2b Flower actinomorphic, petals yellow, rose-purple, or white; fruit a dehiscent capsule, with many ovules:
 - 3a Seeds with an evident coma (tuft of hairs); petals rose-purple or white; capsule slender, more than 10 × as long as broad; basal leaves opposite *Epilobium*
 - 3b Seeds lacking a coma; petals yellow, rose-purple or white; capsule clavate or elongate, thicker, less than 10 × as long as broad; all leaves alternate *Oenothera*

5793000 LUDWIGIA

Ludwigia L., Species plantarum 118 (1753); Harv.: 504 (1862); P.H.Raven: 327 (1963); Schreiber: 2 (1967); R.Fern. & A.Fern.: 190 (1970); Ross: 262 (1972); R.A.Dyer: 409 (1975); P.H.Raven: 333 (1978). Type species *L. perennis* L.

Jussiaea L.: 388 (1753); Harv.: 504 (1862).

Annual or perennial herbs, or undershrubs, sometimes prostrate, often associated with water. *Leaves* alternate or

opposite, simple, usually entire. *Stipules* present, often much reduced. *Flowers* actinomorphic, borne in axils of reduced upper leaves, their opening not highly synchronized. *Sepals* 3–7, persistent after petals have fallen. *Floral tube* 0. *Petals* as many as sepals or 0, yellow, usually entire. *Stamens* as many as or twice as many as sepals; anthers ovoid or oblong. *Pollen* shed in tetrads or singly. *Stigma* entire. *Ovary* with many pluriseriate or uniseriate ovules in each loculus. *Capsule* terete or with 4 or 5 ribs, angles or wings, irregularly loculicidal. *Seeds* ellipsoid, lacking hairs, free or embedded in endocarp at maturity, light brown. *Basic chromosome number*: x = 8.

Species ± 85 and sections 23, worldwide, mainly South America, relatively few in Africa; seven in southern Africa, widespread in subtropical parts, extending to southern Western Cape.

Note: *Ludwigia perennis* L. is treated as occurring in southern Africa in Raven (1963: 367) based on the single collection, *Schlechter 12189*, from Lions Creek. This locality has been found to be in southern Mozambique (Raven 1978: 339). *L. polycarpaea* Short & Peter ex Torr. & Gray has possibly been introduced to southern Africa: *Zambatis 1165* from Klaserie and *Barrett 488a* from Swaziland are housed at PRE. *L. stenorrhaphe* (Brenan) Hara subsp. *macrocephala* (Brenan) P.H.Raven has been collected in Botswana: *Smith 1975* (SRGH, PRE).

- 1a Leaves opposite; petals absent 7. *L. palustris*
- 1b Leaves alternate; petals present:
 - 2a Stamens twice as many as sepals; plants evidently pubescent or glabrous:
 - 3a Sepals 4; seeds free, not embedded in endocarp, pluriseriate; stems without white pneumatophores:
 - 4a Plants densely pubescent to subglabrous; capsules subterete, 17–45 mm long; seeds 0.60–0.75 mm long, raphe equal in diameter to body of seed . . . 2. *L. octovalvis*
 - 4b Plants subglabrous; capsules sharply 4-angled, 10–19 mm long; seeds 0.3–0.4(–0.5) mm long, the raphe narrow 1. *L. erecta*
 - 3b Sepals 5–7, very rarely 4; seeds embedded in endocarp, uniseriate; stems with white spindle-shaped pneumatophores:
 - 5a Seeds firmly embedded in woody, coherent endocarp, pendulous, appearing as bulges in capsule wall ± 1.5 mm apart; leaves with 6–12 lateral veins on each side of midrib; pollen grains shed singly . . . 6. *L. adscendens* subsp. *diffusa*
 - 5b Seeds loosely embedded in horseshoe-shaped pieces of endocarp, horizontal, appearing as bulges in capsule wall ± 0.5 mm apart; leaves with 11–20 lateral veins on each side of midrib; pollen grains shed as tetrads 4. *L. leptocarpa*
 - 2b Stamens as many as sepals; plants glabrous or minutely puberulent:
 - 6a Sepals 3 (very rarely 4 or 5); stems creeping and rooting at nodes; capsules normally tapering to apex; seeds free 3. *L. senegalensis*
 - 6b Sepals 4; stems erect; capsule truncate at apex; seeds loosely embedded in chunks of endocarp at maturity 5. *L. abyssinica*

* B. A. Krukoff Curator of African Botany, Missouri Botanical Garden, P. O. Box 299, St. Louis, Missouri 63166, USA.

** Director, Missouri Botanical Garden, P. O. Box 299, St. Louis, Missouri 63166. Supported by grants from the U.S. National Science Foundation.

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1. *Ludwigia erecta* (L.) Hara in Journal of Japanese Botany 28: 292 (1953); P.H.Raven: 348 (1963); P.H.Raven: 333 (1978). *Jussiaea erecta* L.: 388 (1753); Brenan: 12 (1953b). Type: from America, probably Colombia, from seeds cultivated in Europe.

Jussiaea altissima Perr. ex DC.: 55 (1828). Type: Senegal, in 1825, Perrottet s.n. (G.-DC, lecto.; P, isolecto.).

Isnardia discolor Klotzsch, in Peters: 70 (1861). Type: Mozambique, Zambezi R. between Sena and Lupata Mts. Peters s.n. (B, holo.†).

Subglabrous erect herb, sometimes woody at base, 30 mm to more than 3 m tall, freely branched, stems sharply angled from decurrent leaf bases. *Leaves* 20–130 × 2–45 mm, lanceolate to elliptic, rarely ovate, main veins 16–27 on each side of midrib; petiole 2–15 mm long. *Bracteoles* ± 0.5 mm long. *Sepals* 4, 2–6 × 1.0–1.5 mm. *Petals* 3.5–5.0 × 2.0–2.5 mm. *Stamens* 8. *Pollen* shed in tetrads. *Capsule* 10–19 × 2.0–2.5 mm, sharply 4-angled with 4 nearly flat walls, subsessile or on a pedicel up to 2 mm long. *Seeds* 0.3–0.4(–0.5) × 0.2–0.3 mm, pluriseriate, free, pale brown, raphe narrow. Autogamous. *Chromosome number*: $n = 8$.

Native in the New World from Mexico and Florida to Brazil and Paraguay; introduced throughout tropical Africa, and in southern Africa in Botswana (Figure 1).

Voucher: *Smithers s.n.* (SRGH).

2. *Ludwigia octovalvis* (Jacq.) P.H.Raven in Kew Bulletin 15: 476 (1962); P.H.Raven: 356 (1963); Schreiber: 4 (1967); Ross: 262 (1972); P.H.Raven: 336 (1978). *Oenothera octovalvis* Jacq.: 19 (1760). Type: from West Indies. Figure 2A–C.

Jussiaea suffruticosa L.: 388 (1753); H.Perrier: 20 (1950); Brenan: 14 (1953b). Type: from India. Not *Ludwigia suffruticosa* Walter.

J. angustifolia Lam.: 331 (1789); Harv.: 504 (1862). Type: from the Moluccas.

J. linearis Willd.: 575 (1799); Peters: 70 (1861). Type: Guinea, *Isert s.n.* (B-Willdenow, photograph K). *J. suffruticosa* var. *linearis* (Willd.) Oliv. ex Kuntze: 251 (1891); Brenan: 15 (1953b).

J. linearis Hochst.: 425 (1844), illegitimate homonym non Willd. 1799. Type: South Africa, KwaZulu-Natal, Umhloti and Umgeni Rivers, Krauss 73 (K, iso.).

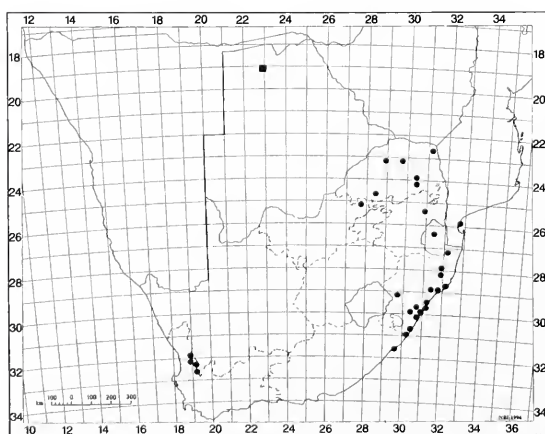


FIGURE 1.—Distribution of *Ludwigia octovalvis*, ●; and *L. erecta*, ■.

L. octovalvis subsp. *sessiliflora* (Micheli) P.H.Raven: 476 (1962); P.H.Raven: 362 (1963); Ross 262 (1972); P.H.Raven: 336 (1978). *J. otonervia* forma *sessiliflora* Micheli: 171 (1875). Type: from Brazil.

J. didymosperma H.Perrier: 148 (1947); H.Perrier: 23 (1950). Type: Madagascar, Firingilava, Perrier 755 (P, lecto.).

L. octovalvis subsp. *breviseipala* (Brenan) P.H.Raven: 476 (1962); P.H.Raven: 365 (1963); Schreiber: 4 (1967); P.H.Raven: 338 (1978). *J. suffruticosa* L. var. *breviseipala* Brenan: 168 (1953a). Type: Cameroun, Cameroun River, in 1863, Mann 2227 (K, holo.).

Robust well-branched herb, up to 4 m tall, freely branched, subglabrous, puberulent, or densely villous. *Leaves* linear to subovate, 7–145 × 1–40 mm, 11–20 main veins on each side of midrib; petiole 0 to 10 mm long. *Bracteoles* 0–1 mm long. *Sepals* 4, 3–15 × 1.0–7.5 mm. *Petals* 3–17 × 2–17 mm. *Stamens* 8. *Pollen* shed in tetrads. *Capsule* 17–45 × 2–8 mm, terete, pale brown with 8 darker ribs, readily and irregularly loculicidal; pedicel up to 10 mm long. *Seeds* 0.60–0.75 × 0.5–0.7 mm including inflated raphe which is equal in size to body of ridged, free, brown seed. Autogamous. *Chromosome numbers* $n = 16$ (only number known for Africa), 24.

Throughout the tropics and subtropics of the world. In southern Africa in N Namibia, Northern Province, North West, Gauteng and Mpumalanga, KwaZulu-Natal and also in southern Western Cape (Figure 1); wet places, 0–1 500 m. A careful study of this species throughout its range has led to the conclusion that it is best not to attempt to recognize infraspecific taxa in a formal taxonomic sense. The most distinct of the entities recognized earlier was subsp. *breviseipala* (Brenan) P.H.Raven, with sepals only 3–6 mm long, which is confined to but widespread in Africa.

Vouchers: *Acocks* 19643; *Rodin* 3037; *Schlechter* 2803; *J.M. Wood* 5341.

3. *Ludwigia senegalensis* (DC.) Troch. in Mémoires de l'Institut Français d'Afrique Noire 2: 378 (1940); P.H.Raven: 371 (1963); Schreiber: 4 (1967); P.H.Raven: 339 (1978). *Prieurea senegalensis* DC.: 58 (1828). *Jussiaea senegalensis* (DC.) Brenan: 164 (1953a). Type: Senegal, in 1825, *Le Prieur s.n.* (G-DC, holo.; P, iso.).

J. pulvinaris (Gilg) Brenan: 163 (1953a); P.H.Raven: 372 (1963). *L. pulvinaris* Gilg: 324 (1903). Type: Angola, Huila, left bank of the Cunene and Humbe, Baum 97 (COI, lecto.; BM, G, P, S, isolecto.).

L. pulvinaris subsp. *lobuyensis* P.H.Raven: 373 (1963). Type: Zaïre, Yatolema-Yahila (route Stanleyville-Ikela) Léonard 1865 (BR, holo.).

Low herb, creeping and rooting at nodes, sometimes completely submerged, stems mostly 50–350 mm long, finely puberulent or glabrous. *Leaves* narrowly lanceolate to rounded, 5–30 × 3–10 mm, veins obscure; petioles 1–2 mm long. *Bracteoles* 0. *Sepals* 3 (rarely 4 or 5), 1–3 mm long. *Petals* 3 (rarely 4 or 5), 2.0–2.5 × 0.5–1.0 mm. *Stamens* 3 (rarely 4 or 5). *Pollen* shed in tetrads. *Capsules* plump, thin-walled, 3.5–9.0 × 1.3–2.0 mm, pale brown, readily and irregularly loculicidal, subsessile. *Seeds* showing clearly through capsule wall, in ± two rows in each locule, free, ovoid, ± 0.7 mm long, rounded at ends, light brown; raphe narrow and inconspicuous. Autogamous or cleistogamous. *Chromosome number*: $n = 8$.

Coastal Senegal to southern Sudan, Zaïre, and south to northern Namibia and probably northern Botswana

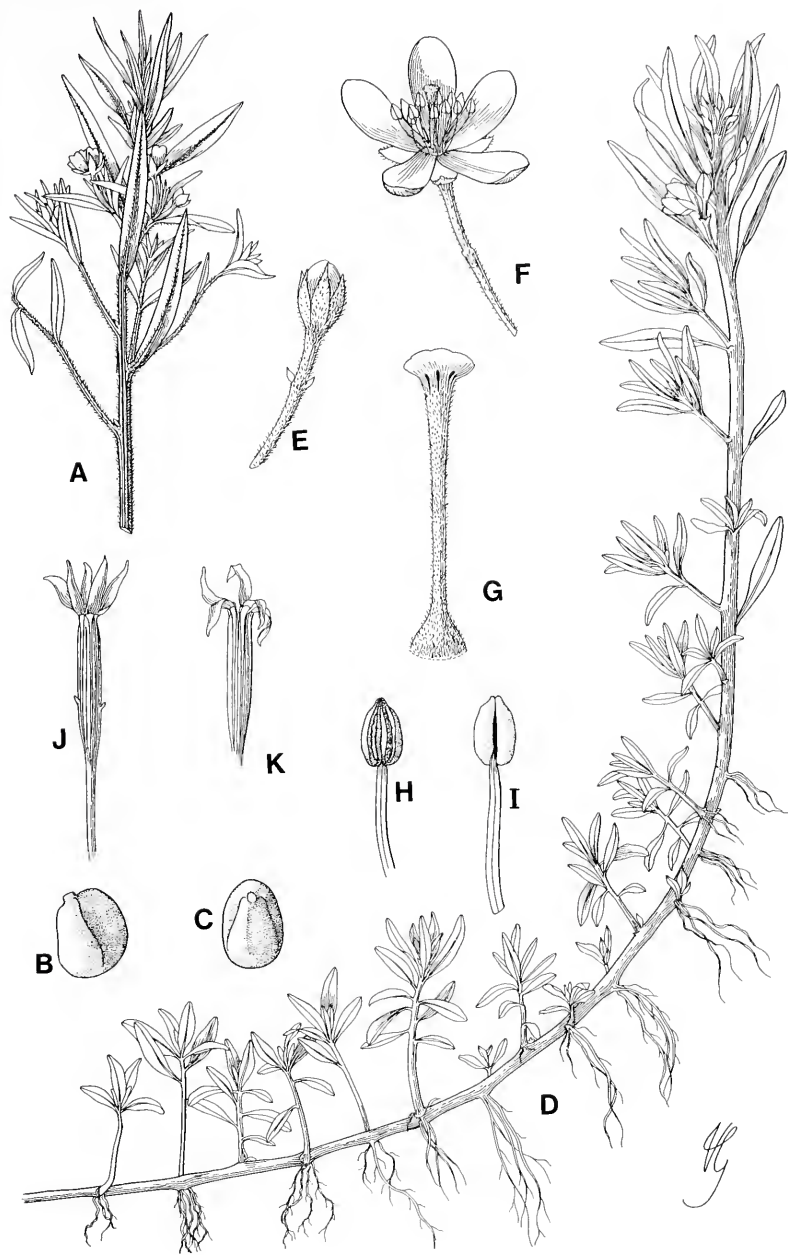


FIGURE 2.—A–C, *Ludwigia octovalvis*. A, flowering branch, $\times 0.5$; B, C, seed, $\times 17$: B, side view; C, ventral view. D–K, *L. adscendens* subsp. *diffusa*. D, habit, $\times 0.5$; E, flower bud, $\times 1.5$; F, flower, $\times 1.5$; G, style and stigma, $\times 6$; H, I, stamen, $\times 6$: H, ventral view; I, dorsal view. J, fruit, $\times 0.5$; K, fruit splitting, $\times 0.5$. A, *Van Rensburg 858*; B, C, *Eyles 120*; D, E, J, K, *Robson & Fanshawe 679*; F–I, *Pope 154*. Reproduced by kind permission of Flora Zambesiaca Managing Committee.

(Figure 3); wet places, sometimes completely submerged.

Vouchers: *Merxmüller & Giess 1902*; *Vlok 1906*.

4. *Ludwigia leptocarpa* (Nutt.) Hara in *Journal of Japanese Botany* 28: 292 (1953); P.H.Raven: 376 (1963); Schreiber: 3 (1967); P.H.Raven: 340 (1978). *Jussiaea leptocarpa* Nutt.: 279 (1818); Brenan: 16 (1953b). Type: from North America.

J. pilosa Kunth: 101 (1823); Mogg in MacNae & Kalk: 150 (1958). Type: from Colombia.

J. seminuda H.Perrier: 146 (1947). Type: Madagascar, south of Maravoay, Boina, *Perrier 17641* (P, lecto.).

Robust hairy plants to 3 m tall, reclining at base but erect and well branched, with erect floating pneumatophores, often forming large masses. *Leaves* broadly lanceolate, long-hairy, 35–180 \times 10–40 mm, 11–20 main veins on each side of midrib; petiole 2–35 mm long. *Bracteoles* 0 or reduced. *Sepals* 5 (rarely 4, 6, or 7) 5.5–11 \times 1.5–3.0 mm. *Petals* 5–11 \times 4–8 mm. *Stamens* twice as many as sepals. *Pollen* shed in tetrads. *Capsule* relatively thin-walled, long-hairy, 15–50 \times 2.5–4 mm, terete, dull light brown, with prominent ribs over locules and less prominent ones over septa, marked on outside with bulges \pm 0.5 mm apart corresponding to position of seeds, slowly and irregularly loculicidal; pedicels 2–20 mm long. *Seeds* uniseriate in each locule of capsule, hor-

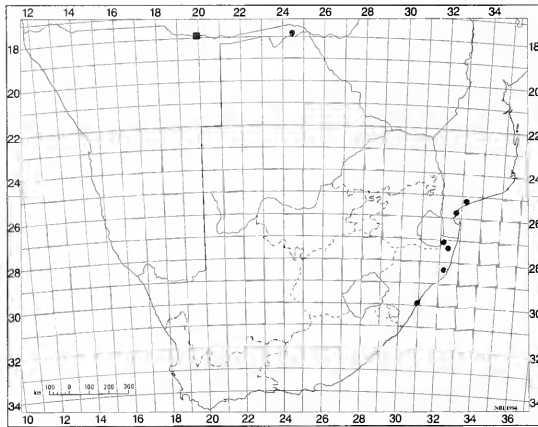


FIGURE 3.—Distribution of *Ludwigia leptocarpa*, ●; and *L. senegalensis*, ■.

izontal, obovoid, 1–1.2 mm long, shiny pale brown; raphe much narrower than body of seed; each seed loosely embedded in an easily detached horseshoe-shaped segment of firm pale brown endocarp \pm 1.0–1.5 mm thick and \pm 1 mm high. Somewhat outcrossing but self-compatible. *Chromosome numbers*: $n = 24$ (in Africa), 16 (in New World).

In the Americas from the southeastern USA to Argentina and in Africa. Rare in southern Africa, in KwaZulu-Natal, northern Namibia and Botswana (Figure 3).

Vouchers: Carson 754; Killick & Leistner 3077; Tinley 225; Ward 5564.

5. *Ludwigia abyssinica* A.Rich., Tentamen florae abyssinicae 1: 274 (1848); P.H.Raven: 380 (1963); Schreiber: 2 (1967); Ross: 262 (1972); P.H.Raven: 340 (1978). Type: Ethiopia, Shire, *Quartin-Dillon & Petit s.n.* (P, holo.).

Jussiaea abyssinica (A.Rich.) Dandy & Brenan in F.W.Andrews: 145 (1950); Brenan: 18 (1953b).

L. jussiaeoides sensu Harv.: 505 (1862), non Desr. (1792).

Stout, subsucculent herb, sometimes woody at base, up to 3 m tall, well branched, glabrous except for minute hairs on midribs and margins of young leaves. *Leaves* lanceolate or broadly elliptic, 20–130 \times 0.5–3.5 mm, 13–22 main veins on each side of midrib; petiole 2–20 mm long. *Sepals* 4, 1.7–3.0 \times 0.4–1.0 mm. *Petals* 1.5–3.5 \times 1.2–2.6 mm. *Stamens* 4. *Pollen* shed in tetrads. *Capsule* relatively thin-walled, glabrous, 10–20 \times 1–2 mm, terete, light brown; pedicels 0.5–3.0 mm long. *Seeds* uniseriate in each locule, diagonal, obovoid, 0.60–0.75 \times 0.4–0.5 mm brown; raphe inconspicuous, each seed loosely but completely embedded in an easily detached piece of soft powdery endocarp 0.6–1.0 \times 0.5–0.7 mm. Autogamous. *Chromosome number*: $n = 24$.

Endemic in Africa from Senegal and Sudan to Madagascar and southern Africa where it occurs only in northern Namibia and in KwaZulu-Natal (Figure 4); in swampy situations.

Vouchers: Loeb 495; Strey 5726; Wood 3877.

6. *Ludwigia adscendens* (L.) Hara subsp. *diffusa* (Forssk.) P.H.Raven in Kew Bulletin 15: 476 (1962); P.H.Raven & Tai: 876 (1979). *Jussiaea diffusa* Forssk.: 210 (1775). *L. diffusa* (Forssk.) Greene: 227 (1891) nom. illeg., non Buch.-Ham. (1824). *J. repens* var. *diffusa* (Forssk.) Brenan: 171 (1953a); *L. adscendens* var. *diffusa* (Forssk.) Hara: 291 (1953). Type: Egypt, Rosetta, banks of Nile, *Forsskål s.n.* (C). Figure 2D–K.

J. stolonifera Guill. & Perr.: 292 (1833). *L. stolonifera* (Guill. & Perr.) P.H.Raven: 390 (1963); Schreiber: 3 (1967); Ross: 262 (1972); P.H.Raven: 341 (1978). Type: Senegal, in 1825, *Perrotet s.n.* (P, holo.).

J. fluitans Hochst.: 425 (1844) nom. illeg., non G.Don 1832; Harv.: 504 (1862). Type: South Africa, KwaZulu-Natal, Umlaas R., *Krauss s.n.* (not seen).

J. alternifolia E.Mey. ex Peters: 69 (1861). Type: South Africa, between Omsamkulu and Omkomas, below 500 ft. *Drège s.n.* (HAL, PR, SAM).

J. diffusa subsp. *albiflora* H.Perrier: 144 (1947). Type: Madagascar, Ankarafontsika, Boina, *Decary 12872* (P!).

Herb with prostrate or ascending stems, rooting at nodes, with conspicuous, white, erect, spindle-shaped, mucronate pneumatophores arising in clusters at nodes of floating stems and from roots; plants more or less densely villous to glabrous. *Leaves* narrowly lanceolate to narrowly elliptic, 20–90 \times 5–17(–23) mm on flowering stems, broader on floating non-flowering branches, 6–12 main veins on each side of midrib; petioles 2–20 mm long. *Bracteoles* \pm 1 mm long. *Sepals* 5, 5–14 \times 1.5–2.8 mm. *Petals* 7–18 \times 4–10 mm. *Stamens* 10. *Pollen* grains shed singly. *Capsule* 10–30 mm long, light brown, with 10 conspicuous darker brown ribs, terete, with bulges \pm 1.5 mm apart, thick-walled, very tardily and irregularly dehiscent; pedicel 5–20 mm long. *Seeds* uniseriate, 1.1–1.3 mm long, pale brown, more or less vertical, firmly embedded in coherent cubes of woody endocarp 1.2–1.5 \times 1.0–1.2 mm, endocarp firmly fused to capsule wall. Somewhat outcrossing but self-compatible. *Chromosome number*: $n = 16$.

Northern Namibia, Botswana and throughout eastern southern Africa (Figure 5), widely distributed in Africa and Middle East; wet places especially along rivers and lakes and often floating, sometimes forming large masses.

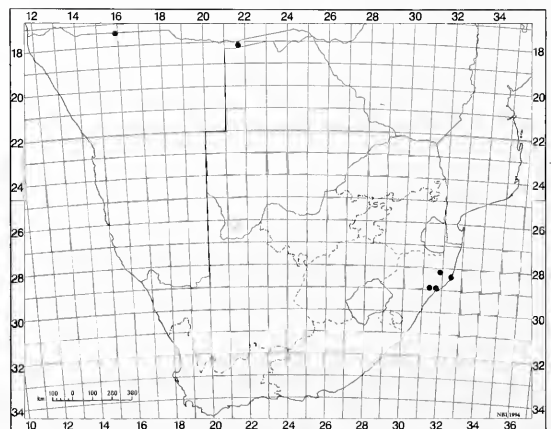


FIGURE 4.—Distribution of *Ludwigia abyssinica*.

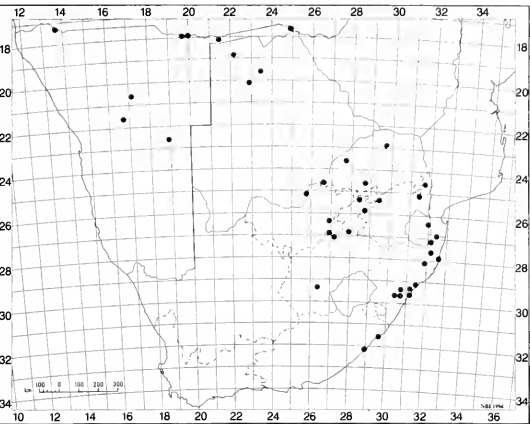


FIGURE 5.—Distribution of *Ludwigia adscendens* subsp. *diffusa*.

Vouchers: Codd 4376; De Winter & Marais 4471; Dinter 2730; Drummond 7148; Ward 2284.

7. *Ludwigia palustris* (L.) Elliott, A sketch of the botany of South Carolina and Georgia 1: 211 (1817); Harv.: 505 (1862); P.H.Raven: 399 (1963); Schreiber: 4 (1967); Ross: 262 (1972); P.H.Raven: 342 (1978). *Isnardia palustris* L.: 120 (1753). Type: from Europe.

Glabrous herb, creeping and rooting at nodes, with opposite leaves, stems at most ascending-decumbent, up to 0.5 m long or perhaps longer, well-branched and forming mats. *Leaves* broadly elliptic or subovate, 7–45 mm × 4–23 mm, 4–8 main veins on each side of midrib. *Bracteoles* 0 or up to 1 mm long. *Sepals* 4, 1.4–2.0 × 0.8–1.8 mm. *Petals* 0. *Stamens* 4. *Pollen* shed singly. *Capsule* elongate-globose, (2.0–)2.5–5.0 × 2–3 mm, obscurely 4-angled, dull light brown, smooth and somewhat corky-walled, but fairly readily and irregularly loculicidal, with a broad green band 0.4–0.5 mm wide on each angle of capsule. *Seeds* pluriserial in each locule, free, elongate-ovoid, 0.6–0.9 × ± 0.3 mm thick, light brown; raphe very narrow. Autogamous. *Chromosome number*: n = 8.

Throughout southern Africa (Figure 6); widespread from temperate North America to Colombia, in Eurasia to Iran and in Africa N of the Sahara and in southern Angola; margins of streams, lakes, wet places.

Vouchers: Dieterlen 1002; Galpin 10128; Parker 4852; Schlechter 6413; Thode A1212.

5795000 EPILOBIUM

Epilobium L., Species plantarum 347 (1753); Harv.: 506 (1862); Adamson: 605 (1950); Schreiber: 1 (1967); P.H.Raven: 309 (1967); R.Fern. & A.Fern.: 199 (1970); Ross: 262 (1972); R.A.Dyer: 410 (1975); P.H.Raven: 343 (1978). Type species: *E. hirsutum* L.

Perennial herbs, often flowering in first year. *Leaves* alternate above, opposite below, entire or toothed. *Stipules* 0. *Flowers* actinomorphic, borne in axils of reduced upper leaves, their opening not highly synchronized. *Sepals* 4,

caducous. *Floral tube* present. *Petals* 4, rose-purple to white, notched. *Stamens* 8; anthers linear to oblong. *Pollen* shed in tetrads. *Ovary* with many uniseriate ovules in each locule. *Stigma* entire or 4-lobed. *Fruit* a slender loculicidal capsule. *Seeds* ellipsoid, with a terminal tuft of hairs (coma), free, brown. *Basic chromosome numbers*: x = 12, 13, 15, 16, or 18 (the only number in Africa).

A large cosmopolitan genus of ± 185 species, with a centre of diversity in North America, 10 species in Africa, four native in southern Africa and fairly widespread.

- 1a Stigma deeply 4-cleft:
 - 2a Stem clothed with long, spreading pubescence; leaves sessile, distinctly clasping at base; fleshy scales absent at base of plant 1. *E. hirsutum*
 - 2b Stems clothed with strigillose pubescence; leaves distinctly petiolate, rounded to obtuse or more rarely subcordate at base with petioles 1.0–2.5 mm long; underground stems invested with white, fleshy, rounded scales 3. *E. capense*
- 1b Stigma entire, clavate:
 - 3a Leaves narrow, subsessile and strongly decurrent; flowers erect at anthesis; petals pale lilac to pink, 2.5–3.5 mm long 2. *E. tetragonum*
 - 3b Leaves broader, distinctly petiolate, narrowly cuneate to attenuate at base; flowers nodding in bud and when opening first, later erect; petals at first white or cream, rose following pollination, 5–15 mm long 4. *E. salignum*

1. *Epilobium hirsutum* L., Species plantarum 347 (1753); Harv.: 506 (1862); Hausskn.: 53 (1884); Burt Davy: 201 (1926); Adamson: 605 (1950); Schreiber: 2 (1967); P.H.Raven: 312 (1967); R.Fern. & A.Fern.: 200 (1970); P.H.Raven: 343 (1978). Type: from Europe.

E. tomentosum Vent.: t. 90 (1802); Brenan: 2 (1953b). Type: from Persia, cultivated in France.

E. mirei Quézel: 90 (1957). Type: Chad, Tigui, in 1956, Quézel s.n. (herb. Quézel, holo.).

Robust herb 0.2–2.5 m tall; rhizome stout; plants more or less white-pubescent all over. *Leaves* mostly opposite, oblong-lanceolate, sessile, clasping at base, coarsely toothed, 20–120 × 4–30 mm. *Inflorescence* with an admixture of glandular trichomes, erect in bud; flowers erect in bud. *Floral tube* 2.5–3.0 mm across, ± 1.0–1.5 mm deep. *Sepals* 6–10 × 2.0–2.5 mm. *Petals* 6–16 × 6–15 mm, bright purplish rose. *Style* 6–10 mm long; stigma deeply 4-lobed, held above anthers at an-

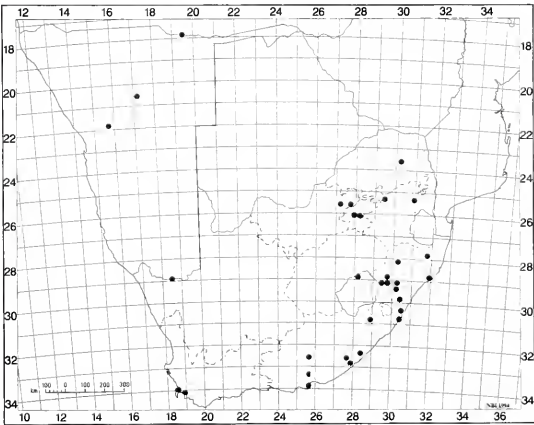
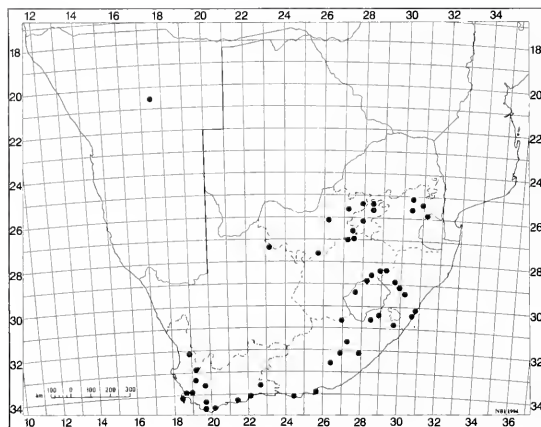


FIGURE 6.—Distribution of *Ludwigia palustris*.

FIGURE 7.—Distribution of *Epilobium hirsutum*.

thesis, lobes 1.5–2.5 mm long. *Capsules* 30–80 mm long; pedicel 2–12 mm long. *Seeds* oblong-obovoid, acute at base, coarsely papillose, 0.90–1.15 mm long, dark brown or even coppery, coma 5–7 mm long, dull white. Outcrossing but self-compatible. *Gametic chromosome number*: $n = 18$. Protandrous.

Widespread in Africa, Europe and temperate Asia, in wet places. In southern Africa it occurs on the Waterberg in Namibia and throughout South Africa (Figure 7), predominantly in montane regions.

Vouchers: Rehmann 4752; Rodin 2586; Rudatis 1649; Schlechter 10446.

2. *Epilobium tetragonum* L., Species plantarum: 348 (1753); Harv.: 597 (1862); Adamson: 606 (1950). Type: from France.

subsp. *tetragonum* P.H. Raven, Flora zambesiaca 4: 318 (1967).

E. adnatum Griseb.: 851 (1852). *E. tetragonum* subsp. *adnatum* (Griseb.) Maire in Jehandiez & Maire: 515 (1932). Type: from Europe.

Perennial herb 0.1–1.0 m tall, producing leafy rosettes from short stolons near base in autumn; plants strigillose, especially above, and with raised lines running down from bases of petioles, these pubescent above. *Leaves* mostly opposite, subsessile and usually decurrent on stem, narrowly lanceolate to nearly elliptical, 15–75 × 3–15(–21) mm, bluish green, evenly and strongly denticulate. *Inflorescence* erect in bud; flowers erect in bud. *Flower tube* ± 1 mm across and deep. *Sepals* 2.8–4.2 × 0.8–1.8 mm. *Petals* 2.5–5.0(–7.0) × 2.0–3.5(–4.5) mm, pale lilac to pink. *Stigma* entire, clavate. *Capsules* (35–)50–110 mm long, on a pedicel 1.2–3.0 mm long. *Seeds* oblong-obovoid, acute at base, coarsely papillose, 1.0–1.3 mm long, brown, coma ± 8–10 mm long, dull white. Autogamous or cleistogamous. *Gametic chromosome number*: $n = 18$.

In South Africa and Lesotho, coastal to high altitudes (Figure 8), probably introduced early from Europe; in Europe east to the Caucasus and Iran, in North Africa from Tangier to Tunisia in the north including Madeira and Canary Islands; in moist places.

Vouchers: Bolus 215; Dieterlen 936; Parker 3638; Schlechter 6129; Thode A320.

3. *Epilobium capense* Buch. ex Hochst. in Flora 27: 425 (1844); Hausskn.: 229 (1884); P.H.Raven: 324 (1967); P.H.Raven: 343 (1978). Type: South Africa, Western Cape, George Dist., Knysna River, *Krauss s.n.* (LZ, holo., destroyed; G, iso.). Figure 9.

E. flavescens E.Mey. ex Harv.: 506 (1862); Hausskn.: 230 (1884). Type: South Africa, KwaZulu-Natal, Umlaas, *Krauss 154* [K, lecto.; BM, G, isoelecto. fide Raven: 324 (1967)].

E. bojeri Hausskn.: 90 (1879). Type: Madagascar, near Be'zongzong, Feb.–Mar., *Bojer s.n.* (JE, lecto.).

E. biforme Hausskn.: 230 (1884). Type: South Africa, Eastern Cape, Somerset East, Boschberg, 1 050 m, *MacOwan 729* (BM, BOL, G, GRA, K, NH, P, SAM).

E. jonathum Hausskn.: 231 (1884). Type: South Africa, Free State, without precise locality, *Cooper s.n.* (K, holo.; BOL, iso.).

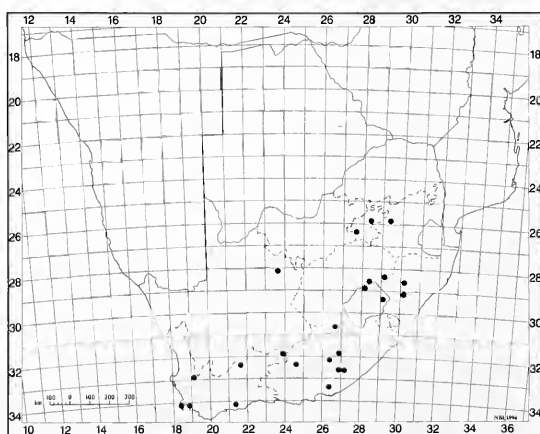
E. karsteniae Compton: 297 (1967). Type: Swaziland, Mbabane Dist., swamps near Forbes Reef, 4500–5000ft, *Compton 30487* (NBG, PRE).

Perennial herb 0.1–1.2 m tall; underground stems vertical or nearly so, densely invested with thick white, fleshy, rounded scales ± 4 × 2–10 mm after first year; plants strigillose with some glandular trichomes in the more densely lanceolate, serrate with prominent forward-directed teeth, 20–50 × 0.4–2.5 mm; petioles 1.0–2.5 mm long. *Inflorescence* erect in bud; flowers erect or somewhat drooping in bud. *Floral tube* 2.0–2.5 mm across, 1.1–1.5 mm deep. *Sepals* 4.2–10.0 × 1.2–2.5 mm. *Petals* 6–16 × 3.0–10.5 mm, bright rose-purple, paler purplish, creamy, or white. *Stigma* white, 4-lobed, lobes 0.7–2.0 mm long. *Capsules* 30–90 mm long; pedicel 10–60 mm long. *Seeds* oblong-obovoid, papillose, 1.3–1.6 mm long, brown, coma 5–7 mm long, dingy white. Outcrossing or self-pollinating. *Gametic chromosome number*: $n = 18$.

Moist places and mountain meadows in Madagascar and in Africa from southern Tanzania to the southern Western Cape (Figure 10).

Vouchers: MacOwan 729; Schlechter 10095; Tyson 1813; Wood 686.

4. *Epilobium salignum* Hausskn. in Oesterreichische Botanische Zeitung 29: 90 (1879); Hausskn.: 236 (1884); Brenan: 5 (1953b); P.H.Raven: 331 (1967);

FIGURE 8.—Distribution of *Epilobium tetragonum* subsp. *tetragonum*.

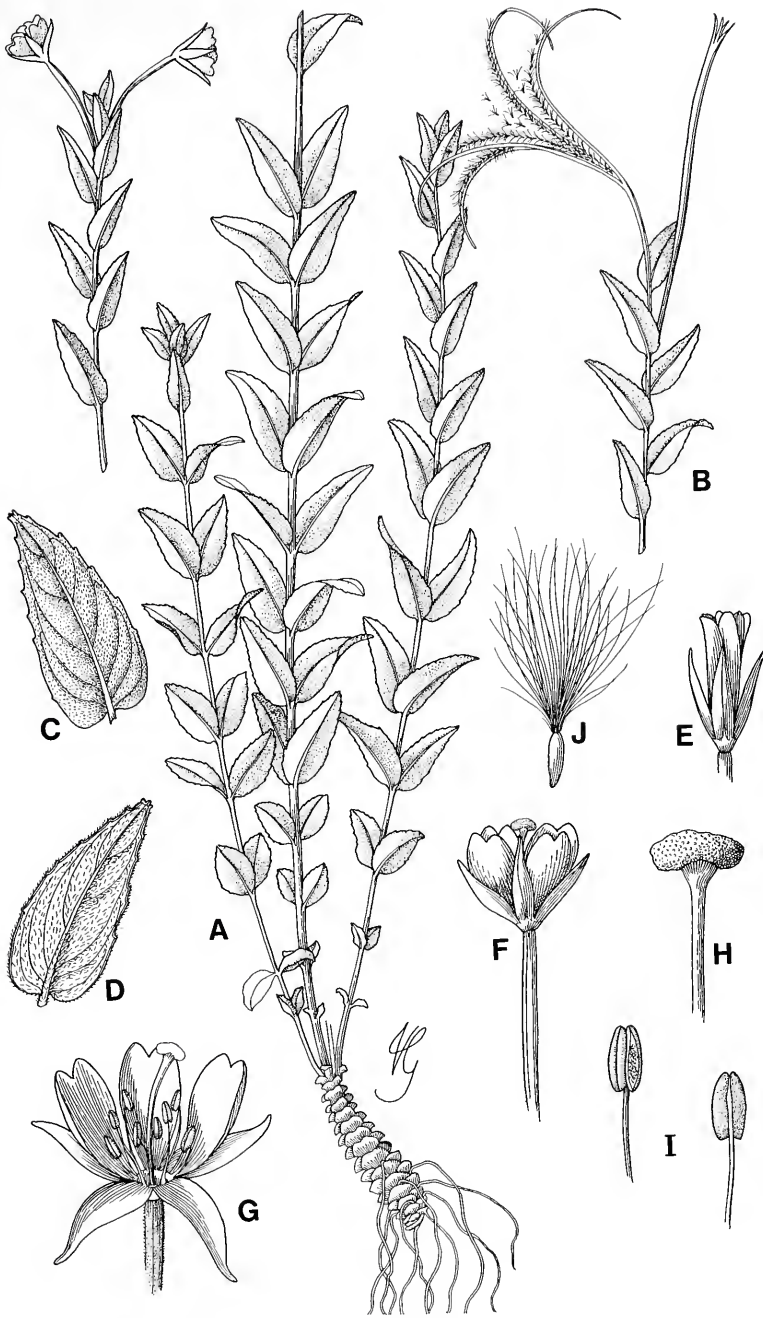


FIGURE 9.—*Epitobium capense*. A, habit, $\times 0.5$; B, branch with mature fruit, $\times 0.5$. C, D, leaf, $\times 1$: C, upper surface; D, undersurface. E, bud, $\times 2$. F, G, flower: F, $\times 1.5$; G, with petal removed to show style and stamens, $\times 2$. H, part of style with stigma, $\times 6$; I, stamen, $\times 4$; J, seed, $\times 4$. A, C, D, *Robson* 245; B, J, *Stohr* N44; E–I, *Chase* 5883. Reproduced by kind permission of Flora Zambesiaca Managing Committee.

P.H.Raven: 345 (1978). Type: Madagascar, Antananarivo and Be'zongzong, *Bojer s.n.* (P, lecto.).

E. neriophyllum Hausskn.: 19 (1880). Type: South Africa, Eastern Cape, Somerset East, Boschberg 900 m, *MacOwan* 1487 (K, lecto.; GRA, NH iso. lecto.).

E. mundtii Hausskn.: 235 (1884). Type: South Africa, Western Cape, Cape Peninsula, in 1820, *Mundt & Maire s.n.* (JE, lecto.).

E. natalense Hausskn.: 235 (1884). Type: South Africa, KwaZulu-Natal, 'Natal Bay', *Gueinzus s.n.* (LZ, holo., destroyed; JE, iso. lecto.).

E. oliganthum Baker: 345 (1886) nom. illeg., non Michx. (1803).

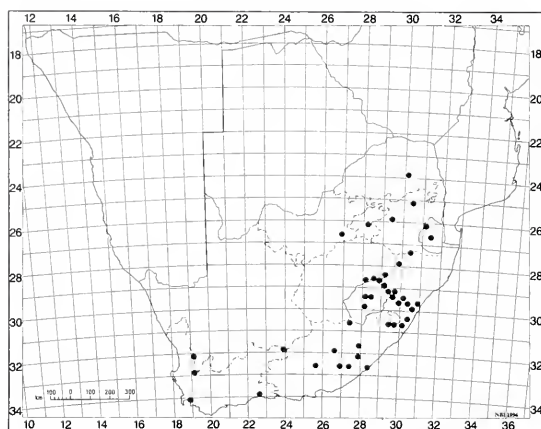
E. benguellense Welw. ex Hiern: 378 (1898). Type: Angola, Huila, Monino River, *Welwitsch* 4458 (LISU, lecto.; BM, COI, G, K, isolecto.). *E. tetragonum* subsp. *benguellense* (Welw. ex Hiern) Engl.: 773 (1921).

E. tetragonum subsp. *benguellense* var. *welwitschii* Engl.: 773 (1921). Type: Angola, Huila, Quilengues, rio Caculovar, *Welwitsch* 4459 (LISU, lecto.; B, COI, G, P, isolecto.).

E. madagascariense H.Lév.: 225 (1907). Type: Madagascar, Ranobé, near Sirabe, in 1895, *Forsyth-Major s.n.* (G, holo.).

E. perrieri H.Lév.: 3 (1917). Type: Madagascar, Ankaratra, 900 m, *Perrier* 6630 (P, lecto.).

E. schinzii H.Lév.: 225 (1907). Type: South Africa, KwaZulu-Natal, Noodsberg, 600–900 m, *J.M. Wood* 5282 (Z, holo., not seen; BM, NH, SAM, iso.).

FIGURE 10.—Distribution of *Epilobium capense*.

Perennial herbs 0.2–1.6 m tall; strongly rhizomatous; rhizomes lacking scales, long-spreading and giving rise to new leafy shoots; plants evenly strigillose, sometimes sparsely so, with faintly marked lines running down from margins of pedicels. *Leaves* mostly opposite, very narrowly to narrowly elliptic, rarely almost lanceolate, weakly serrulate or rarely serrate, 20–80 × 3–20 mm; petiole 1–8 mm long. *Inflorescence* erect in bud, to 300 mm long; bracts usually not much reduced; flowers nodding in bud and when opening first, later erect. *Floral tube* 0.8–2.0 mm across, 1.5–2.3 mm deep. *Sepals* 3.5–8.5 × 1.2–2.2 mm. *Petals* 5–15 × 2–7 mm, at first white or cream, then rose following pollination. *Stigma* usually clavate, rarely subcapitate, entire. *Capsules* 30–70 mm long, on a pedicel 8–45 mm long. *Seeds* oblong-obovoid, obtuse at base, minutely reticulate, 1.00–1.35 × 0.35–0.60 mm; light brown or tan, coma ± 5–9 mm long, copious, white. Mainly autogamous. *Gametic chromosome number*: $n = 18$.

Extending in southern Africa along the eastern mountains to the Transkei, including Lesotho and Swaziland (Figure 11), from the highlands of tropical and temperate Africa and Madagascar; moist places, 500–3 000 m.

Vouchers: Flanagan 665; Rudatis 1346; Scheepers 625.

5819000 GAURA

Gaura L., Species plantarum 1: 347 (1753); L.: 163 (1754); R.A.Dyer: 410 (1975). Type species: *G. biennis* L.

Gauridium Spach: 379 (1835a).

Schizocarya Spach: 325, 381 (1835b); Spach: 170, 283 (1835c).

Annual, biennial, or perennial herbs. *Leaves* alternate, entire to deeply lobed. *Stipules* 0. *Inflorescence* a spicate raceme, sharply delimited, not leafy, more or less conspicuously pedunculate. *Flowers* usually strongly zygomorphic, borne in axils of much reduced upper leaves (bracts), opening either near sunset or near sunrise and fading within a day. *Floral tube* present, long and narrow. *Sepals* 4, caducous. *Petals* 4, white, usually sharply clawed, entire. *Stamens* 8; anthers linear, sporogenous tissue divided by sterile tissue into discrete packets. *Pollen* shed singly. *Stigma* deeply 4-lobed. *Ovary* with 1 or 2 ovules in each locule. *Capsule* indehiscent, nutlike,

with hard, woody walls, septa incomplete and fragile, not evident at maturity. *Seeds* ovoid, yellowish to pale brown. *Basic chromosome number*: $x = 7$.

A genus of 21 species of North America, centring in the Great Plains and Texas. Two species are naturalized in South Africa.

1a Inflorescences strigillose; plants rhizomatous; flowers opening near sunset; fruits evidently stipitate, with stipe 2–8 mm long 1. *G. sinuata*

1b Inflorescence villous; plants clumped; flowers opening near sunrise; fruits sessile, broad-based 2. *G. lindheimeri*

1. **Gaura sinuata** Nutt. ex Ser. in DC., Prodrum 3: 44 (1828). Type: from USA.

Aggressively rhizomatous perennial herb, forming extensive mats with well-branched stems 200–600 mm tall; plants subglabrous or sparsely pubescent, stems strigillose and with long, spreading hairs; leaves densely strigillose in relatively hairy plants. *Leaves* linear to narrowly oblanceolate, 10–110 × 1–20 mm, sparsely sinuate-dentate, rarely subentire, often undulate. *Inflorescence* 100–300 mm long, simple or branched; bracts lanceolate to narrowly ovate, 1–5 × 0.5–2.0 mm. *Flowers* opening near sunset. *Floral tube* 2.5–5.0 mm long. *Sepals* 7–14 × 1.25–2.50 mm, strigillose. *Petals* 7.0–14.5 × 3–7 mm, white, fading pink. *Ovary* outside of floral tube, strigillose. Body of *capsule* 8–15 × 1.5–3.5 mm; stipe 2–8 mm long. *Seeds* (1–)2–4 × 2–3 mm, light to reddish brown. Self-incompatible. *Gametic chromosome number*: $n = 14$.

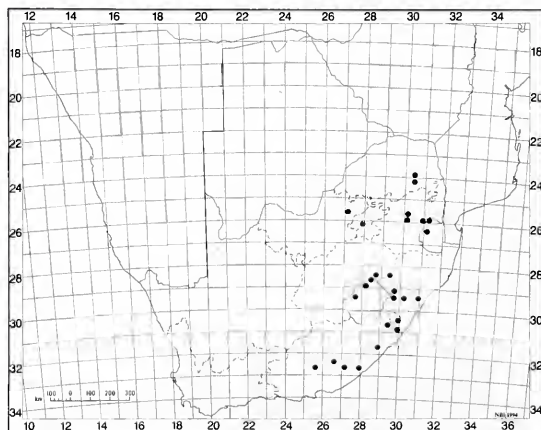
Native to USA, Texas and Oklahoma; widely introduced elsewhere in USA, in Italy and locally in South Africa on Van Staden's Pass (Figure 12); a noxious weed limited by self-incompatibility.

Vouchers: Theron 1837; Wells 3192.

2. **Gaura lindheimeri** Engelm. & A.Gray in Boston Journal of Natural History 5: 217 (1845). Type: from USA. Figure 13.

G. filiformis Small var. *munzii* Cory: 420 (1937). Type: from USA.

Robust clumped perennial herb, usually branching copiously from a heavy underground crown; stems erect or

FIGURE 11.—Distribution of *Epilobium salignum*.

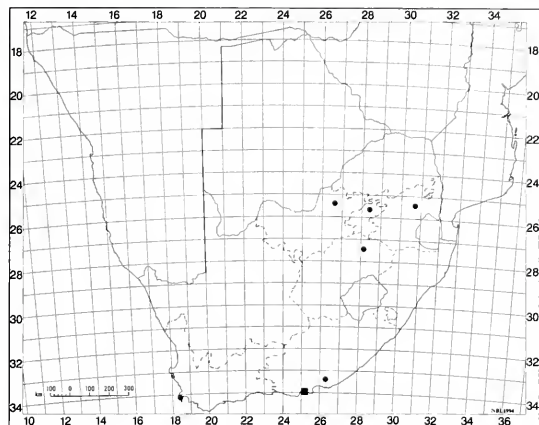


FIGURE 12.—Distribution of *Gaura sinuata*, ■; and *G. lindheimeri*, ●.

more often arching outward from crown to form a full, clumped plant 0.5–1.5 m tall; entire plant villous, inflorescence with a more or less dense admixture of glandular trichomes. *Leaves* very narrowly elliptic (to occasionally narrowly oblanceolate), 5–90 × 0.1–1.3 mm, coarsely and remotely serrate, occasionally subsinuately so. *Inflorescence* 100–800 mm long, well branched or simple; bracts narrowly to broadly elliptic, 4–11 × 1.5–6.0 mm. *Flowers* opening near sunrise. *Floral tube* 4–9 mm long. *Sepals* 8.5–17.0 × 1–2 mm. *Petals* white, fading to light or deep pink, 10.5–15.0 × 5–10 mm. *Capsule* 6–9 × 2.0–3.5 mm. *Seeds* 1–4, 2.3 × 1.0–1.5

mm, yellowish to light brown. Self-incompatible. *Gametic chromosome number*: $n = 7$.

Native to USA, Louisiana and Texas; widely cultivated and occasionally spontaneous; occurring in South Africa in Gauteng, Free State and the Western Cape (Figure 13).

Vouchers: Galpin 14525; Goldblatt 1436; Leach & Bayliss 12582.

5804000 OENOTHERA*

Oenothera L., Species plantarum 346 (1753); L.: 163 (1754); Harv.: 505 (1862); Munz: 79 (1965); Schreiber: 5 (1967); P.H.Raven: 330 (1978); R.A.Dyer: 410 (1975). Type species: *O. biennis* L.

Annual, biennial, or perennial herbs. *Leaves* alternate, entire to pinnatifid. *Stipules* 0. *Flowers* actinomorphic, borne in axils of reduced leaves, often clustered near ends of stems, opening either near sunset or near sunrise and usually fading within a day. *Floral tube* present. *Sepals* 4, caducous. *Petals* 4, yellow, white or rose-purple, usually entire. *Stamens* 8; anthers linear. *Pollen* shed singly. *Stigma* deeply 4-lobed. *Ovary* with many pluriserial or uniserial ovules in each locule. *Capsule* stout, loculicidal. *Seeds* lacking hairs, free, usually brown. *Basic chromosome number*: $x = 7$.

Approximately 125 species, all native to North and South America, but widely naturalized in the Old World; 14 species recorded in southern Africa.

- 1a Petals white or rose-purple; flowers opening near sunrise or sunset; capsules evidently clavate:
 - 2a Petals rose-purple, 5–10 mm long; flowers opening near sunrise, diurnal 13. *O. rosea*
 - 2b Petals white, fading purplish, 20–35 mm long; flowers opening near sunset, nocturnal 14. *O. tetraptera*
- 1b Petals yellow; flowers opening near sunset; capsules not evidently clavate, sometimes slightly enlarged in upper third:
 - 3a Floral tube longer than 60 mm:
 - 4a Buds densely grey-strigillose; open flowers ± reaching apex of stem and mostly concentrated there; capsules sessile, broad at base; seeds sharply angular 1. *O. jamesii*
 - 4b Buds villous; open flowers not reaching apex of stem, well spaced; capsules cylindrical; seeds rounded, not sharply angular:
 - 5a Plants not forming a basal rosette, softly villous; bracts longer than capsules they subtend; capsules ± enlarged in upper third 8. *O. affinis*
 - 5b Plants forming a basal rosette, coarsely and densely villous; bracts shorter than capsules they subtend; capsules not enlarged above 7. *O. longiflora*
 - 3b Floral tube shorter than 60 mm:
 - 6a Capsules broad at base; seeds sharply angular; open flowers ± reaching apex of stem:
 - 7a Petals 35–50 mm long 3. *O. glazioviana*
 - 7b Petals 7–25 mm long:
 - 8a Floral tube 10–18 mm long; plant exclusively appressed pubescent (strigillose) throughout 5. *O. villosa*
 - 8b Floral tube 20–50 mm long; plant glandular pubescent and with eglandular spreading hairs (villous):
 - 9a Tips of sepals subterminal, divergent; petals 7–20 mm long; tip of inflorescence often arched 4. *O. parviflora*
 - 9b Tips of sepals terminal, erect; petals 10–25 mm long; tip of inflorescence erect 2. *O. biennis*
 - 6b Capsules cylindrical or tapering at base; seeds rounded, not sharply angular; open flowers well-spaced down stem, not especially clustered above:
 - 10a Leaves usually deeply and coarsely toothed; buds curved upward 11. *O. laciniata*
 - 10b Leaves with ± blunt, shallow teeth or entire to remotely sinuate-dentate; buds various:
 - 11a Petals 15–45 mm long:
 - 12a Stems prostrate or decumbent; plant canescent; mature buds curved upward; leaves entire to remotely sinuate-dentate 12. *O. drummondii*
 - 12b Stems erect; plant ± strigillose, never canescent; mature buds erect; leaves serrate 9. *O. stricta*
 - 11b Petals 3–12 mm long:
 - 13a Plants appearing glabrous to naked eye, but actually with very short erect hairs; bracts cuneate at base, as long as or longer than capsules they subtend; capsules 1.5–2.0 mm thick 6. *O. indecora*
 - 13b Plants evidently erect-pubescent; bracts rounded at base, clearly shorter than capsules they subtend; sepals often flecked with dark reddish brown; capsules 2–3 mm thick 10. *O. parodiana* subsp. *parodiana*



FIGURE 13.—*Gaura lindheimeri* Engelm. & A.Gray. A, flowering branch, $\times 0.4$; B, capsule, scale bar: 2 mm. Artist: Yevonn Wilson-Ramsey.

1. *Oenothera jamesii* Torr. & A.Gray, Flora of North America 1: 493 (1840); Munz: 131 (1965). Type: from Oklahoma or Texas.

Stout, erect winter annuals or biennials, simple or sparsely branched, ± 1.0 – 1.5 m tall, forming a rosette; stems strigillose, with scattered longer subappressed hairs, red papillae few or 0. *Leaves*: rosette leaves 60–200 mm long; cauline leaves broadly lanceolate, conspicuously sinuate-serrulate, acuminate at apex, strigillose, 50–120 \times 20–35 mm; petioles 0–12 mm long. *Bracts* 10–50 mm long. *Floral tube* 80–130 mm long, strigillose and glandular-pubescent. *Sepals* 35–60 mm long, strigillose, with free tips 3–6 mm long. *Petals* 40–50 mm long, yellow. *Anthers* 12–22 mm long. *Capsule* 20–50 \times 6–10 mm, strigillose but with short fine and longer coarser hairs. *Seeds* sharply angled, 1.5–2.0 mm long. Outcrossing but self-compatible. *Chromosome number*: $n = 7$ (7 bivalents or small rings at meiotic metaphase I).

Native to North America from Oklahoma and southern Kansas to northeastern Mexico. In southern Africa widespread in Northern Province, North-West, Gauteng and Mpumalanga and local in northern Cape, coastal KwaZulu-Natal and the Western and Eastern Cape (Figure 14). First recorded in 1926 at Welverdiend Station.

Vouchers: Codd 2756; Galpin 2585; Stadler s.n.

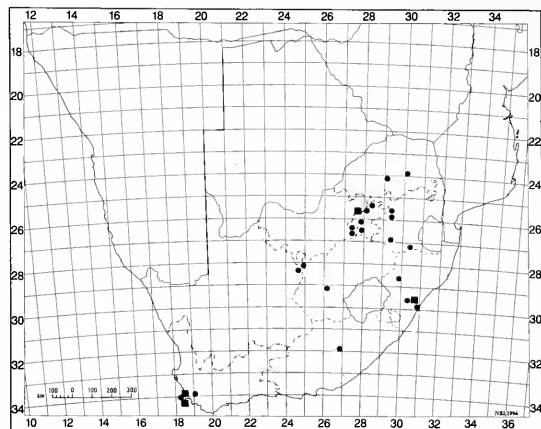


FIGURE 14.—Distribution of *Oenothera jamesii*, ●; and *O. biennis*, ■.

2. *Oenothera villosa* Thunb., Prodrum plantae capensium: 75 (1794); W.Dietr. & P.H.Raven: 382 (1976). Type: South Africa, Western Cape, without precise locality, Thunberg s.n. (UPS, holo.).

O. biennis L. sensu Harv.: 505 (1862) pro parte.

O. strigosa subsp. *canovirens* (Steele) Munz: 136 (1965). Type: from USA.

The African plants belong to subsp. *villosa*.

Biennial 50–200 mm tall, simple or branched plants, forming a rosette, exclusively greyish strigillose throughout, some of hairs arising from red papillae. *Cauline leaves* narrowly lanceolate, acute to subacuminate at apex, 70–150 \times 14–30 mm. *Bracts* 10–50 mm long. *Floral tube* 20–37 mm long, strigillose. *Sepals* 10–18 mm long, strigillose, free tips 1–3 mm long. *Petals* 8–15(–17) mm long, yellow, often ageing orange. *Anthers* 4–7 mm long. *Capsules* 18–43 \times 4–6 mm, strigillose. *Seeds* sharply angled, 1–2 mm long. Autogamous. *Chromosome number*: $n = 7$ (ring of 14 at meiotic metaphase I).

Native of North America, first recorded from the Cape Peninsula by Thunberg in 1772–1775, and occasionally since (Figure 15).

Vouchers: Ecklon & Zeyher 1762; Esterhuysen s.n.; Salter 8895.

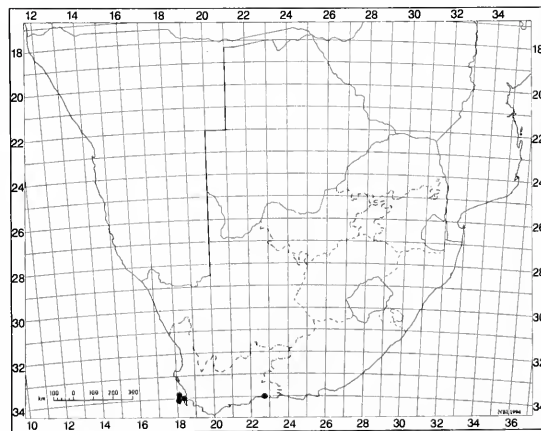


FIGURE 15.—Distribution of *Oenothera villosa*.

3. *Oenothera biennis* L., Species plantarum 346 (1753); non sensu Harv.: 505 (1862) vide *O. villosa*; Munz: 132 (1965). Type: from Europe.

Weedy biennial 0.3–2.0 m tall, simple or branched, forming a rosette; stems pubescent throughout with short appressed hairs (strigillose) and usually longer curved or spreading hairs, some arising from red papillae. *Cauline leaves* lanceolate, sinuate-denticulate, sharply acute to acuminate at apex, strigillose and with some longer hairs, 80–170 × 20–50 mm; petioles short or 0. *Bracts* 10–40 mm long. *Floral tube* 25–40 mm long, with some gland-tipped as well as non-glandular hairs. *Sepals* 8–28 mm long, pubescent as in floral tube, free tips terminal, erect, 1.5–3.0 mm long. *Petals* 10–25 mm long, yellow, generally aging old gold. *Anthers* 4–7 mm long. *Capsule* 14–40 × 3–6 mm, strigillose and villous to subglabrous. *Seeds* sharply angled, 1.2–1.8 mm long. Autogamous. *Chromosome number*: $n = 7$ (ring of 14 or ring of 8 and ring of 6 at meiotic metaphase I).

Native of eastern USA and Canada. Local in southern Africa in Northern Province, North-West, Gauteng, Mpumalanga, Lesotho and northern Karoo (Figure 14). First recorded in 1910 at the Crocodile River (Ermelo District).

Vouchers: Burtt Davy 9311; Collins 9884; Werger 1330.

4. *Oenothera glazioviana* Micheli, in Flora brasiliensis 13,2: 178 (1875). Type: from Rio de Janeiro, Brazil.

O. erythrosepala (Borbás) Borbás: 203 (1902); Borbás: 245 (1903); Munz: 130 (1965). *Onagra erythrosepala* Borbás: 203 (1902).

O. lamarkiana sensu auct., non Sér.

Erect, bushy biennial to short-lived perennial, 0.8–1.2 m tall, forming a rosette; stems ± densely crisp-puberulent and with numerous longer spreading hairs, many arising from red papillae. *Cauline leaves* broadly lanceolate- to ovate-oblong, crinkled, obtuse to acute at apex, substrigillose, mostly 50–100 × 25–40 mm; petioles 0–20 mm long. *Bracts* 10–30(–50) mm long. *Floral tube* 35–50 mm long, glandular-pubescent and villous. *Sepals* 30–40 mm long, glandular-puberulent and villous, free tips 5–8 mm long. *Petals* 35–50 mm long, yellow. *Anthers* 10–12 mm long. *Capsule* 20–25(–30) × 5–6 mm, villous and glandular-puberulent. *Seeds* sharply angled, 1.3–1.7 mm long. Outcrossing but self-compatible. *Chromosome number*: $n = 7$ (ring of 12 and 1 bivalent at meiotic metaphase I).

A species of garden origin, widely distributed in cultivation and as a naturalized plant in the Old World and North America; in southern Africa local throughout eastern southern Africa, although not in Swaziland, and as far south as Knysna (Figure 16). First recorded in 1891 in Eastern Cape.

Vouchers: Dieterlen 633; Flanagan 723; Fourcade 2048; Strey 7285.

5. *Oenothera parviflora* L., Systema naturae edn 10: 988 (1759); Munz: 121 (1965). Type: from North America or Europe.

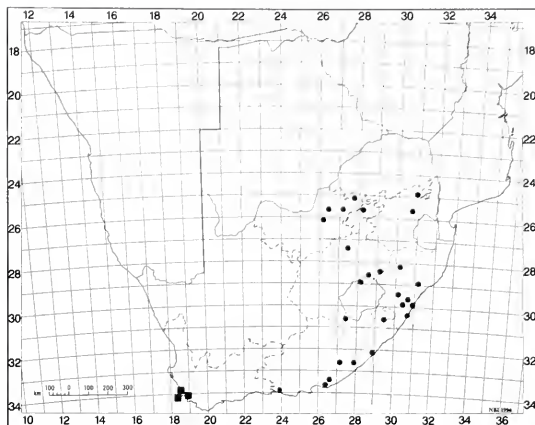


FIGURE 16.—Distribution of *Oenothera glazioviana*, ●, and *O. parviflora*, ■.

Weedy biennial 1.0–1.5 m tall, simple or branched, forming a rosette; stems subglabrous to strigillose-puberulent and with looser longer spreading hairs that may arise from red papillae. *Cauline leaves* narrowly lanceolate, shallowly denticulate, acute to subacuminate at apex, strigillose to subglabrous, 50–120 × 12–30 mm; petioles short. *Bracts* 10–30 mm or longer. *Floral tube* 20–40 mm long, subglabrous or strigillose or more or less glandular-pubescent and strigillose, often also with somewhat stiffer erect hairs. *Sepals* mostly 8–20 mm long, usually pubescent as in floral tube, sometimes almost shaggy-villous, free tips subterminal, divergent, 1–5 mm long. *Petals* 7–20 mm long, yellow, ageing somewhat orange. *Anthers* 4–7 mm long. *Capsule* 15–40 × 3–6 mm, ± scattered to densely villous and ± strigillose, only strigillose or almost glabrous. *Seeds* sharply angled, 1.2–1.8 mm long. Autogamous. *Chromosome number*: $n = 7$ (ring of 14 at meiotic metaphase I).

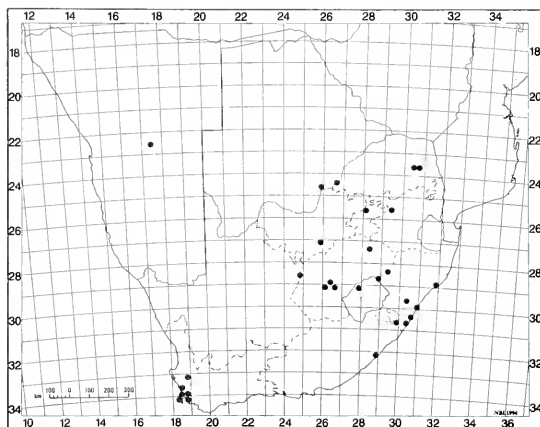
Native of eastern USA and eastern Canada. Recorded in southern Africa locally in Western Cape between the Peninsula and Stellenbosch (Figure 16). First recorded in 1884.

Vouchers: Goldblatt 1435; Marloth 86; Purcell 442.

6. *Oenothera indecora* Cambess. in Saint-Hilaire, Flora brasiliensis meridionalis 2: 268 (1830); Munz: 658 (1935); P.H.Raven: 332 (1978); W.Dietr.: 515 (1978). Type: from Brazil.

O. indecora subsp. *bonariensis* W.Dietr. 519 (1978). Type: from Argentina.

Erect annual with several branches, up to 600 mm tall from base, everywhere covered with fine, erect pubescence. *Leaves* 10–60 mm long, sinuate-dentate, lanceolate or narrowly ovate, sessile. *Inflorescence* erect, buds also erect; flowers borne in axils of much reduced leaves, opening near sunset. *Floral tube* 8–15 mm long. *Sepals* 5–6 mm long with slender free tips ± 1 mm long. *Petals* 3–6 mm long, bright yellow, fading reddish. *Anthers* ± 2 mm long; filaments 4–6 mm long. *Style* surrounded by anthers at anthesis; stigma with linear lobes 2–3 mm long. *Capsule* 15–22 × 1.5–2.0 mm, cylindric, not winged, subsessile. *Seeds* 0.7–1.3 mm long, broadly el-

FIGURE 17.—Distribution of *Oenothera indecora*.

lipsoïd, indistinctly and shallowly pitted, light brown. Autogamous. *Chromosome number*: $n = 7$ (7 bivalents or ring of 14 at meiotic metaphase I).

Native of South America. Scattered in weedy places and cultivated fields in eastern southern Africa, and also in Western Cape and central Namibia (Figure 17); not recorded in Swaziland or Lesotho. First recorded in 1918 on the Cape Peninsula, and only after 1948 elsewhere.

Vouchers: Parker 4849; Scheepers 270; Seydel 1965; Strey 7094.

7. *Oenothera longiflora* L., Mantissa plantarum 227 (1771); W.Dietr. 509 (1978). Type: cultivated in Sweden from seeds from Buenos Aires, Argentina.

The African plants belong to subsp. *longiflora*.

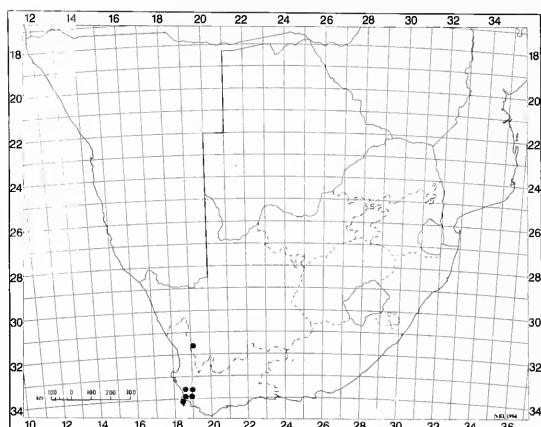
Annual or biennial, 400–800 mm tall, forming a rosette, simple or branched, densely long-villous and sparsely glandular-pubescent. *Cauline leaves* oblong to elliptic or narrowly ovate to ovate, short-acute, truncate to subcordate at base, sessile, 15–60 × 10–25 mm. *Bracts* 10–30 mm long, usually red along margins. *Floral tube* (65–)80–100 mm long, often streaked and flecked with dark red. *Sepals* 20–25 mm long, free tips 1–2 mm; apices erect or divergent. *Petals* 20–30 mm long, yellow, often with a red spot at base. *Anthers* 7–13 mm long. *Capsule* mostly curved and with 4 clearly distinct crenate valves at apex, 30–45 × 3–4 mm. *Seeds* ellipsoid to broadly ellipsoid, 1.5–2.0 mm long, brown. Autogamous. *Chromosome number*: $n = 7$ (ring of 14 at meiotic metaphase I).

Native in southern Brazil, Uruguay and Argentina. Recorded in southern Africa only locally in Western Cape, from the Peninsula to Citrusdal (Figure 18). First recorded in 1835.

Vouchers: De Jongh sub Galpin 4932; Hanekom 1233.

8. *Oenothera affinis* Cambess. in Saint-Hilaire, *Flora brasiliæ meridionalis* 2: 269 (1830); W.Dietr.: 524 (1978). Type: from southern Brazil.

Erect annual, 0.4–1.5 m high, without a rosette, unbranched or ± well branched throughout, densely to

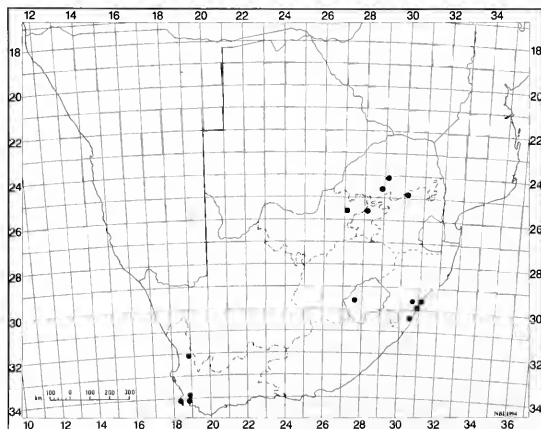
FIGURE 18.—Distribution of *Oenothera longiflora*.

sparsely long-villous, and densely glandular-pubescent. *Cauline leaves* cultrate to narrowly lanceolate, apex acute, acute to rounded at base, sessile, 50–150 × 5–15 mm. *Bracts* (30–)40–90 mm long. *Floral tube* 80–110(–130) mm long. *Sepals* 20–35 mm long, free tips 1.5–4.0 mm long, erect or divergent. *Petals* very broadly obovate, (15–)20–40 mm long, yellow. *Anthers* 10–14 mm long. *Capsule* 20–40(–50) × 3–4 mm, thicker in upper third, with 4 valves clearly separated at apex. *Seeds* elliptic in outline, 1.5–2.0 × 0.5–0.6 mm. Outcrossing but self-compatible. *Chromosome number*: $n = 7$ (7 bivalents, ring of 14 or intermediate configurations at meiotic metaphase I).

Native in South America, and widely naturalized elsewhere. Reported in southern Africa, from coastal KwaZulu-Natal, Lesotho, Northern Province, North-West, Gauteng and Western Cape (Figure 19). First recorded in 1902 in the central Northern Province.

Vouchers: Adamson 3076; Burt Davy 1248; De Jongh sub Galpin 6529; Dieterlen 1352.

9. *Oenothera stricta* Ledeb. ex Link ('striata'), Enumeratio plantarum horti regii berolinensis altera 1: 377 (1821); Munz: 661 (1935), tab. 82, figs B1–B9; P.H.Raven: 330 (1978); W.Dietr. 536 (1978). Type: from Chile. Figure 20C–K.

FIGURE 19.—Distribution of *Oenothera affinis*.

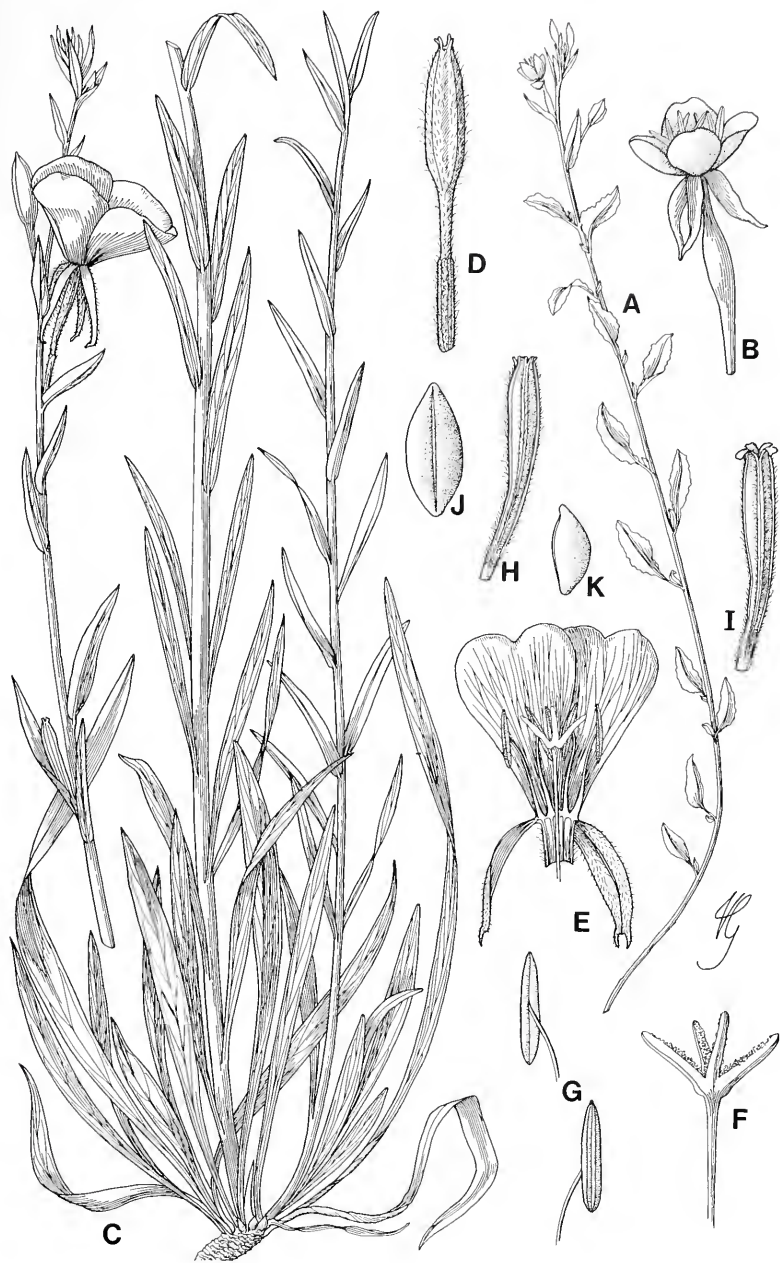


FIGURE 20.—A, B, *Oenothera rosea*: A, flowering branch, $\times 0.5$; B, flower, $\times 1.5$. C–K, *O. stricta*: C, habit, $\times 0.5$; D, flower bud, $\times 1$; E, flower partly dissected, $\times 1$; F, style and stigma, $\times 2$; G, anther, two aspects, $\times 2$; H, I, fruit, $\times 1$; H, before dehiscence; I, after dehiscence. J, K, seed, J, ventral view, $\times 12$; K, lateral view, $\times 8$. A, Drummond 4887; B, Brooke 233; C, Phipps 2844; D, H, I, Chase 2960; E–G, Munz 169; J, K, Goldsmith 126/68. Reproduced by kind permission of Flora Zambesiaca Managing Committee.

O. nocturna sensu Harv.: 506 (1862), non Jacq.; Burt Davy: 202 (1926). Type: from South Africa.

The African plants are subsp. *stricta*.

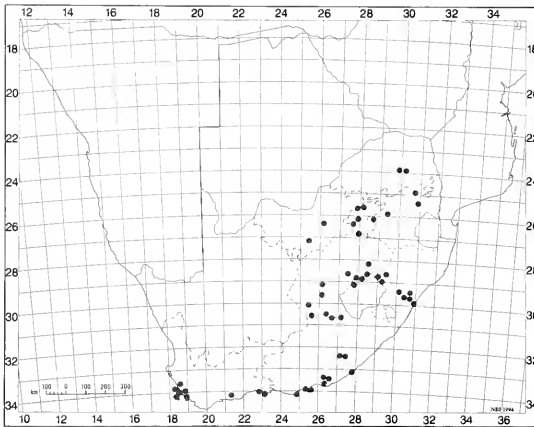
Annual or short-lived perennial, forming a rosette, often flowering in first year, with several stout stems 0.3–1.0 m tall from a taproot, subglabrous below, villous and glandular pubescent above. *Cauline leaves* 20–80 mm long, narrowly oblanceolate, sparsely serrulate, sessile. *Flowers* in axils of much reduced upper leaves. *Floral tube* 20–45 mm long, slender. *Sepals* 15–22 mm long, with free tips ± 2 mm long. *Petals* 15–32 mm long, bright yellow, fading reddish. *Anthers* 7.0–8.5 mm long. *Capsule* cylindric, 20–40 \times 3–4 mm,

enlarged upward, not winged, sessile. *Seeds* ± 1 –5 mm long, brown, obovoid, in 1 row in each locule. Auto-gamous. *Chromosome number*: $n = 7$ (ring of 14 at meiotic metaphase I).

Native to southern Chile and Argentina, widely naturalized elsewhere. Widespread in South Africa and Lesotho (Figure 21). First recorded in 1888, in Eastern Cape.

Vouchers: Dieterlen 169, Galpin 365; Leendertz 412; Parker 4391.

10. *Oenothera parodiana* Munz, Physis 11: 283 (1933); W.Dietr.: 564 (1978). Type: from Argentina, Prov. Buenos Aires.

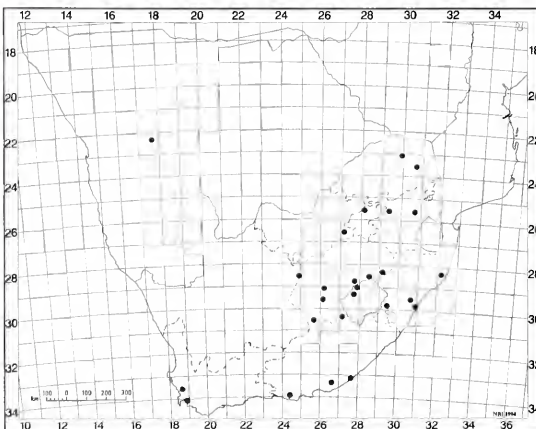
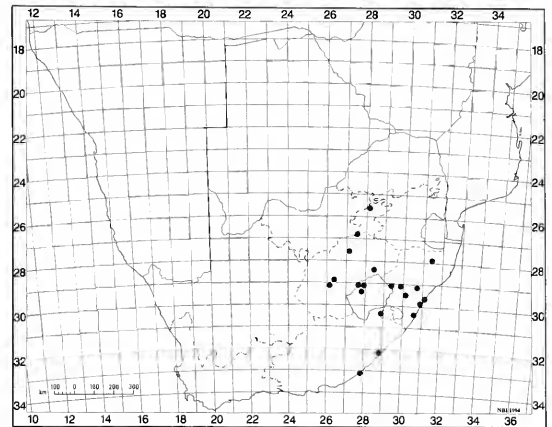
FIGURE 21.—Distribution of *Oenothera stricta*.

The African plants are subsp. *parodiana*.

Erect or somewhat decumbent annual or biennial, 300–700 mm high, forming a rosette, main stem simple or branched, obliquely ascending or arching side branches arising from rosette, densely to sparsely long- and short-villous and glandular-pubescent, or densely to sparsely villous and glandular-pubescent. *Cauline leaves* narrowly oblong to lanceolate or oblanceolate, acute, rounded to truncate at base, sessile, 25–150 × 5–10 mm. *Bracts* 10–20 mm long. *Floral tube* 10–20 mm long, sometimes flecked and streaked with red. *Sepals* 5–9 mm long, often flecked with red, free tips 1.0–1.5 mm long, erect or divergent. *Petals* 7–12 mm long, yellow. *Anthers* 3–8 mm long. *Capsule* 20–30 × 2.5–5.0 mm thick, valves often clearly separated at end. *Seeds* ellipsoid, 1.1–1.5 × 0.5–0.8 mm. Autogamous. *Chromosome number*: $n = 7$ (ring of 14 at meiotic metaphase I).

Native in South America, from southern Brazil to Argentina. In southern Africa, common in KwaZulu-Natal, Free State, Northern Province, North-West, Gauteng and Mpumalanga, and apparently local in Eastern Cape, southern Western Cape, Lesotho, and central Namibia (Figure 22). First recorded in 1909 in Mpumalanga, but becoming common only after 1940.

Vouchers: Leendertz 9202; Ruch 2328; Seydel 2686; Ward 6192.

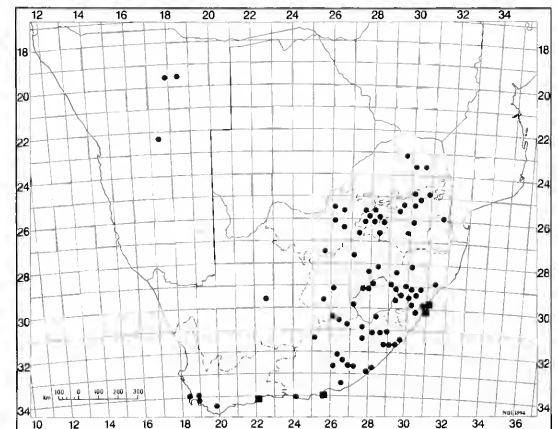
FIGURE 22.—Distribution of *Oenothera parodiana*.FIGURE 23.—Distribution of *Oenothera laciniata*.

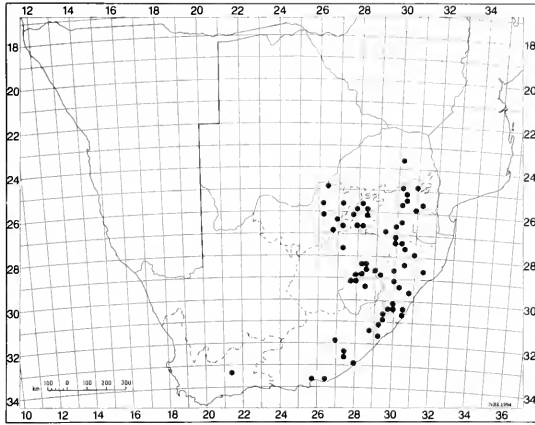
11. *Oenothera laciniata* Hill, The complete vegetable system, edn. 1: 12, Appendix: 64, t. 10–70 (1767); Hill: 172, t. 6 (1768). Munz: 654 (1935); P.H. Raven: 330 (1978). Type from seeds obtained near Charleston, S Carolina.

Erect, often rank, annual, not forming a rosette, usually with many branches from base, these often decumbent and up to 0.4 m long, strigillose and densely villous above, especially in the inflorescence, also glandular-pubescent. *Cauline leaves* 10–80 mm long, sinuate-dentate or sinuate-pinnatifid, more rarely subentire, lanceolate, lower ones petiolate, upper ones sessile. *Flowers* borne in axils of much reduced leaves. *Floral tube* 12–35 mm long. *Sepals* 5–15 mm long, with slender free tips 0.5–3.0 mm long. *Petals* 5–22 mm long, bright yellow, fading reddish. *Anthers* 2–5 mm long. *Capsule* 15–50 × 2–4 mm, cylindric, not winged, subsessile. *Seeds* ± 1 mm long, obovoid, coarsely and conspicuously pitted, light brown. Autogamous. *Chromosome number*: $n = 7$ (ring of 14 at meiotic metaphase I).

Native in eastern N America. Widespread in eastern southern Africa, although not recorded from Swaziland, and the lowveld of Northern Province and Mpumalanga (Figure 23). First recorded in 1905 in KwaZulu-Natal.

Vouchers: Gordon Gray 863; Jacot Guillarmod 4717; Pont 669; Ward 3763.

FIGURE 24.—Distribution of *Oenothera rosea*, ●; and *O. drummondii*, ■.

FIGURE 25.—Distribution of *Oenothera tetraptera*.

12. *Oenothera drummondii* Hook. in Curtis' Botanical Magazine 61: t. 3361 (1834); Munz: 107 (1965). Type: from Texas.

The African plants are subsp. *drummondii*.

Suffrutescent perennial not forming a rosette, with prostrate or decumbent, mostly simple stems 200–500 mm long, densely canescent-pubescent throughout. *Cauline leaves* oblanceolate or more often oblong-ovate to -obovate, sessile or nearly so, densely appressed-pubescent, 10–40 mm long, often with one pair or more of rounded teeth or lobes near base, not much reduced up the stem. *Flowers* borne in axils of leaves. *Floral tube* 25–50 mm long, densely villous. *Sepals* 20–30 mm long, commonly reflexed in pairs at anthesis, free tips divergent, 1–3 mm long. *Petals* yellow, turning reddish, 25–45 mm long. *Anthers* 7–12 mm long. *Capsule* sessile, cylindrical, 25–55 mm long, about 3 mm thick, often curved, villous. *Seeds* ellipsoid to broadly ellipsoid, pitted, 1.0–1.2 mm long, brown. Outcrossing, but self-compatible. *Chromosome number*: $n = 7$ (usually 7 bivalents at meiotic metaphase I).

Native in coastal North America from S Carolina to eastern Mexico, with a second subspecies in lower California. Naturalized locally in southern Africa north of Durban and in the Port Elizabeth area (Figure 23). First reported in 1912.

Vouchers: Paterson 2343; Urton 316; Watmough 492.

13. *Oenothera rosea* L'Hér. ex Aiton, Hortus kewensis edn 1, 2: 3 (1789); Burt Davy: 202 (1926); Schreiber: 5 (1967); P.H.Raven: 332 (1978). Type grown from seeds collected in Peru. Figure 20A, B.

Weedy perennial, not forming a rosette, often blooming in first year, 200–500 mm high, with numerous stems from a somewhat woody caudex, strigillose throughout, more densely so in inflorescence. *Cauline leaves* 20–50 mm long, oblanceolate to narrowly obovate, entire to somewhat pinnatifid at base of blade, acute, base narrowly cuneate; petioles 4–30 mm long, distinct. *Flowers* borne in axils of much reduced leaves. *Floral tube* 4–8 mm long, slender. *Sepals* 5–8 mm long, commonly co-

herent and deflexed to one side in anthesis. *Petals* 4.5–10.0 mm long, bright purplish rose. *Anthers* 2.5–4.0 mm long. *Capsule* clavate, 8–10 × 3–4 mm, strigillose, narrowly winged, base passing gradually into hollow, ribbed stipe 5–20 mm long. *Seeds* oblong-ovoid, ± 0.6 mm long. Autogamous. *Chromosome number*: $n = 7$ (ring of 14 at meiotic metaphase I).

Weed of American origin, now widespread in all warm parts of the world. Recorded throughout South Africa, Swaziland and Lesotho, and in extreme southern and northern Namibia (Figure 24). Introduced in the 1890's.

Vouchers: Burt Davy 1039; Dieterlen 1317; Flanagan 589; Salter 8902.

14. *Oenothera tetraptera* Cav., Icones et descriptiones plantarum 3: 40, t. 279 (1796); Burt Davy: 202 (1926); P.H.Raven: 332 (1978). Type: from Mexico.

Weedy perennial, not forming a rosette, often flowering in first year, 150–400 mm high, with numerous stems from a somewhat woody caudex, covered with long spreading hairs throughout, and also with shorter appressed hairs. *Cauline leaves* 30–100 mm long, oblanceolate or elliptic, irregularly sinuate-pinnatifid in outline to entire, much reduced above; petioles mostly shorter than 10 mm. *Flowers* borne in axils of much reduced leaves. *Floral tube* 8–10 mm long. *Sepals* 20–30 mm long, usually coherent and deflexed to one side in anthesis. *Petals* 25–35 mm long to 14 mm long late in season, white, fading purplish. *Anthers* 5–6 mm long. *Capsule* clavate, 10–15 × 6–8 mm, with prominent wings 2–3 mm wide, base gradually narrowed into a hollow, ribbed stipe 5–25 mm long. *Seeds* obovoid, ± 1.3 mm long. Self-compatible. *Chromosome number*: $n = 7$ (7 bivalents at meiotic metaphase I).

Native in the New World from Texas to northern South America. In southern Africa common in the Northern Province, North-West, Gaunteng, Mpumalanga, KwaZulu-Natal, Free State, and Lesotho, and extending into Eastern Province (Figure 25). First recorded in 1883 at Queenstown.

Vouchers: Dieterlen 327; Galpin 13215; Schlechter 6416; Tyson 1994.

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A survey of the mycobiota of a natural Karoo pasture

C. ROUX* and K.T. VAN WARMELO**

Keywords: ecology, facial eczema, Karoo, litter, mycobiota, pasture, photosensitivity, South Africa

ABSTRACT

The survey of a natural Karoo pasture from 1978 to 1982 showed that a wealth and variety of fungi were present in the semidesert environment. Hyphomycetes and Coelomycetes represented 45.8% and 34.6% respectively of the taxa identified. A total of 135 genera was identified of which *Altenaria alternata*, *Cladosporium* spp. and *Fusarium* spp. of the Hyphomycetes, *Phoma* spp., *Ascochyta* spp. and *Camarosporium* spp. of the Coelomycetes and *Leptosphaerulina* spp., of the Ascomycetes represented the most prevalent fungi in this order. This survey has shown conclusively that *Pithomyces chartarum*, which is associated with photosensitivity diseases of sheep, can always be recovered from the veld if the correct isolation techniques are employed. A number of new records for South Africa, as well as undescribed species, have been found, highlighting the necessity of correct methods and intensity of approach.

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1. INTRODUCTION

Climatically the Karoo can be defined according to the Holridge System (Price 1975) as semi-arid to arid and warm to cool temperate. Characteristics are erratic, patchy rainfall and occasional unseasonal cold weather when snow may fall in the high-lying areas, even during mid-summer (Figure 1).

The original vegetation of the survey area, which according to Acocks (1979, 1988) was grassland, has largely been replaced by karroid veld, and there is general agreement that the process of deterioration is continuing with desertification advancing towards the northeast.

The flora of the region is rich in species (Acocks 1988) but the habitat is unpredictable with patches of temporary pioneer vegetation (Southwood 1977), comprising species such as *Tribulus terrestris* L., which become established when the first early summer rains fall.

'Geeldikkop', the hepatogenous photosensitivity disease of mainly sheep, was first described by Hutcheon (1886). Theiler (1918) showed that ingestion of *T. terrestris*, especially wilted material, was directly implicated in the aetiology of the disease. He reported the presence of a *Colletotrichum* sp. on such material and linked it to the disease as a possible cause. According to Watt & Breyer-Brandwijk (1962) the ingestion of *T. terrestris* causes a condition similar to 'geeldikkop' called 'big head' reported from Colorado and Texas. The plants are high in saponins and thus inherently toxic. In New Zealand (Thornton & Percival 1959; Thornton & Ross 1959) *Pithomyces chartarum* from ingested grasses proved to be responsible for the development of hepatogenous photosensitivity and facial eczema, which is very similar to 'geeldikkop'. Very few researchers have been successful in reproducing 'geeldikkop' under field conditions (Van Tonder *et al.* 1972). Kellerman *et al.* (1980) were able to show that the combination of *P. chartarum* and *T. terrestris* gave histopathological lesions similar to those found during natural outbreaks of the disease.

Fungi from litter in the Karoo have received little attention. Doidge (1950) reported only a few fungi from the Karoo, mainly collected by MacOwan in the Eastern Cape. On *Lycium* spp., amongst others, *Puccinia lycii* Kalchbr. was recorded. No fungi were recorded on *Tribulus terrestris* L. *Pithomyces karoo* Marasas & Schumann (1972) was published after a study of litter from the Karoo.

Relatively few surveys of mycobiota have been published from South Africa. Eicker (1973) studied the my-

* To whom correspondence should be addressed. Mycology Unit, Biosystematics Division, Plant Protection Research Institute, Agricultural Research Council, Private Bag X134, 0001 Pretoria.

** Botany Department, Rand Afrikaans University, P.O.Box 524, Auckland Park, 2006 Johannesburg.

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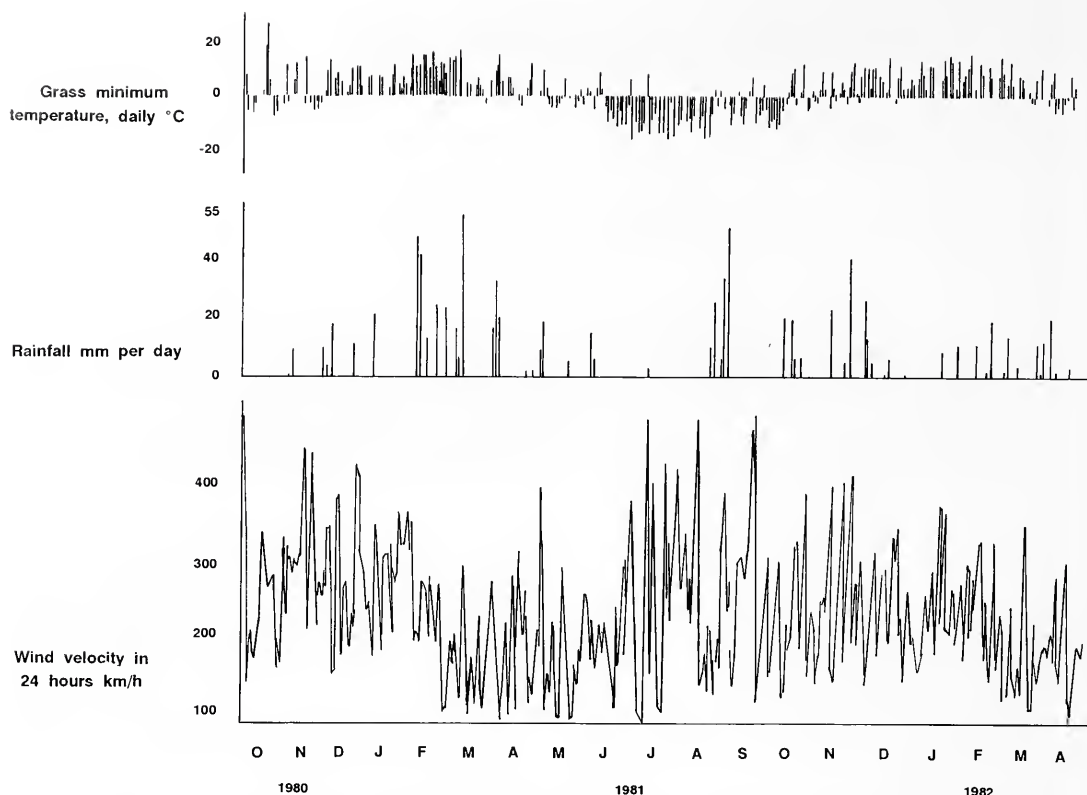


FIGURE 1.—Weather data for the period 1980/82, Middelburg. Grass minimum temperature, rainfall and wind velocity per day.

cobiota of *Eucalyptus maculata* leaf litter. Papendorf & Jooste (1974) described five species of fungi from wheat field debris after isolation by the dilution plate method. Eicker (1976) studied the mycoflora of *Panicum coloratum* associated with an outbreak of photosensitivity of sheep for an 11 month period.

Bezuidenhout (1977) studied the hyphomycetes (mitotic fungi, Hawksworth *et al.* 1995) associated with *Cenchrus ciliaris* L., a fodder grass, over an 11 month period. Van der Merwe *et al.* (1979) studied the aerospora of an *Eragrostis curvula* (Schrad.) Nees pasture in South Africa.

An interim report based on the present survey of *Pithomyces chartarum* was published stating that a further 315 isolates were tested for sporidesmin production in culture of which most did not produce the toxin (Annual Report 1981).

The present survey was initiated to determine the incidence of *P. chartarum* in natural Karoo pasture at a time when 'geeldikkop' was likely to occur. The original scope of this study was increased considerably when it became apparent that much valuable information could be gained if a general survey of the mycobiota of the area was done.

2. MATERIALS AND METHODS

2.1. Sampling, monitoring sites and dates

The survey was conducted at the Grootfontein Agricultural College Farm, Middelburg, Eastern Cape Prov-

ince. Sampling and monitoring were done over a period of four seasons during which weekly or fortnightly samples were collected. The sampling procedure involved taking samples from up to seven different plants as well as litter, at three points (1978/79) and later in two camps of a hectare each from 1979 onwards (Table 1).

1978/79 survey

Three sampling points, A, B and C were chosen after completion of a botanical survey of an area where *Tribulus terrestris* occurred. The nature of the communities at the sampling points varied significantly regarding crown cover, basal cover and density.

Point A was situated in a community with a reasonably high density of perennial Karoo bushes. Therefore, the crown cover was such that wind movement between the individual bushes was possible. The basal cover of *T. terrestris* was fairly high but decreased with time.

Point B was situated in a very dense community of perennial Karoo bushes which allowed virtually no wind movement at soil level. Very few *T. terrestris* and other pioneer plants, such as *Galenia sarcophylla*, were present.

Point C was situated in an area where only one *Lycium cinereum* bush of 1.5 m in height was present besides *T. terrestris*. Virtually no other vegetation was present at this point at the onset of the survey.

TABLE 1.—Sampling dates and numbers of sampling units collected

		Summer				Winter			Summer				No. of sampling units per year		
		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.		
1978	3 points								*	*	*	*	*	15 700	78/79
1979		*	*	*	*	*	*	*				*	*		
1980	2 camps	*	*	*	*	*	*	*			*	*	*	4 050	79/80
1981		*	*	*	*	*	*	*	*	*	*	*	*	28 600	80/81
1982				*	*	*								discontinued +	

+ The survey was discontinued because of the third successive year of drought and the resulting deterioration of the vegetation.

Weekly samples of litter were collected, including *T. terrestris* when present, after rains had fallen during December 1978. A total of 34 samples of litter and 20 of *T. terrestris* plants were studied during this period of seven months.

1979/80 survey

Shifting of plant communities at the points previously chosen necessitated another approach. It was decided to establish two camps (A and B) of one hectare each; the one (A) with a fair cover of *T. terrestris*, the other (B) without. Five sheep were put into Camp A and the following plants were sampled: the Karoo bushes *Galenia sarcophylla*, *G. procumbens*, *Felicia muricata* and *Lycium cinereum* and the grasses *Eragrostis lehmanniana* and *Cynodon incompletus*. Other plant materials sampled were unidentified litter and *T. terrestris*. Initially Camp B contained very little *T. terrestris* and, because of well established stands of perennials such as *Felicia muricata* and *Lycium cinereum*, was less susceptible to invasion by *T. terrestris* and other pioneers. The density of the communities in Camp B was much higher than in Camp A, and *T. terrestris* was only found in the corner of the camp adjacent to Camp A. Very few *Pentzia* spp. and other typical Karoo bushes grew in the two camps.

Sampling took place from December 1979 to the end of March 1980 on a fortnightly basis.

1980/81 survey

This survey started in September 1980 and was continued through 1981. A total of 52 weekly samples was collected and studied from each of the two camps. This time every plant species named in the 1979/80 survey was, however, sampled and studied individually. Thus four species of bushes, two species of grasses, litter and, when available, *T. terrestris* were sampled for a full calendar year.

1981/82 survey

This survey was a continuation of the 1980/81 survey, and continued to the end of March 1982.

2.1.1. Sampling methods employed

Samples were taken up to a height of 150 mm which corresponds to the vertical zone grazed by merino sheep. Care was taken to lift litter from the soil surface so as to pick up as few eelworms as possible. The camps were sampled at random to obtain representative samples. If wet, due to rain or dew, the samples were sun-dried before

packing into paper bags, every sample from each plant species packed separately, and locality, date and species were noted. Samples were then posted to Pretoria which took approximately 10 days.

The sampling units used were individual leaves, leaflets and 10 mm lengths of stems and grass blades. The material was sorted and samples from as many different leaves and stems as was possible were taken. Fifty units from each of the samples were planted out directly on potato carrot agar (PCA) (Johnston & Booth 1983) to which 125 mg/l Albamycin T (Upjohn) had been added prior to autoclaving. Initially some samples from Camps A and B were first washed by shaking in tap water mixed with Teepol (Shell Chemicals) 1:100 in a wrist shaker for 10 minutes to dislodge superficial conidia. The washed material was planted out directly after this treatment. The first five samples collected during the 1980/81 survey were studied this way.

The plates were incubated for a period of seven days at 24°C with intermittent mixed near-UV and daylight fluorescent light from a height of 300 mm on a 12 h/d cycle. The presence of fungi on the material studied was noted and isolations made of *P. chartarum* and other noteworthy fungi. Chemical assays for sporidesmin, the toxin produced by *P. chartarum*, were done according to the method of Marasas *et al.* (1972) on a number of the isolates. Some of these cultures were also used to produce bulk cultures with which to dose sheep.

2.1.2. Sampling methods which proved inappropriate

2.1.2.1. Spore trapping

A Burkard volumetric spore trap was operated from 26-01-1976 to 26-02-1976 on a 24 hour basis in the toxic camp. Only one conidium of *P. chartarum* was collected (Roux 1977). It was later found that the spore trap had to operate too high above the ground to pick up the conidia released at a much lower level. No spore trap functioning on a suction principle can operate in a sandy environment at a low level. The use of a spore trapping device was therefore not employed further.

2.1.2.2. Exposure of Petri dishes

This technique had the dual advantage that it gave the best indication of how many airborne conidia there were, and isolates obtained in this manner were alive and could be used for sporidesmin assays almost right away. However, the distance between the sampling site at Grootfontein and Pretoria made this an impracticable method. It was noted that under windy conditions the Petri dishes

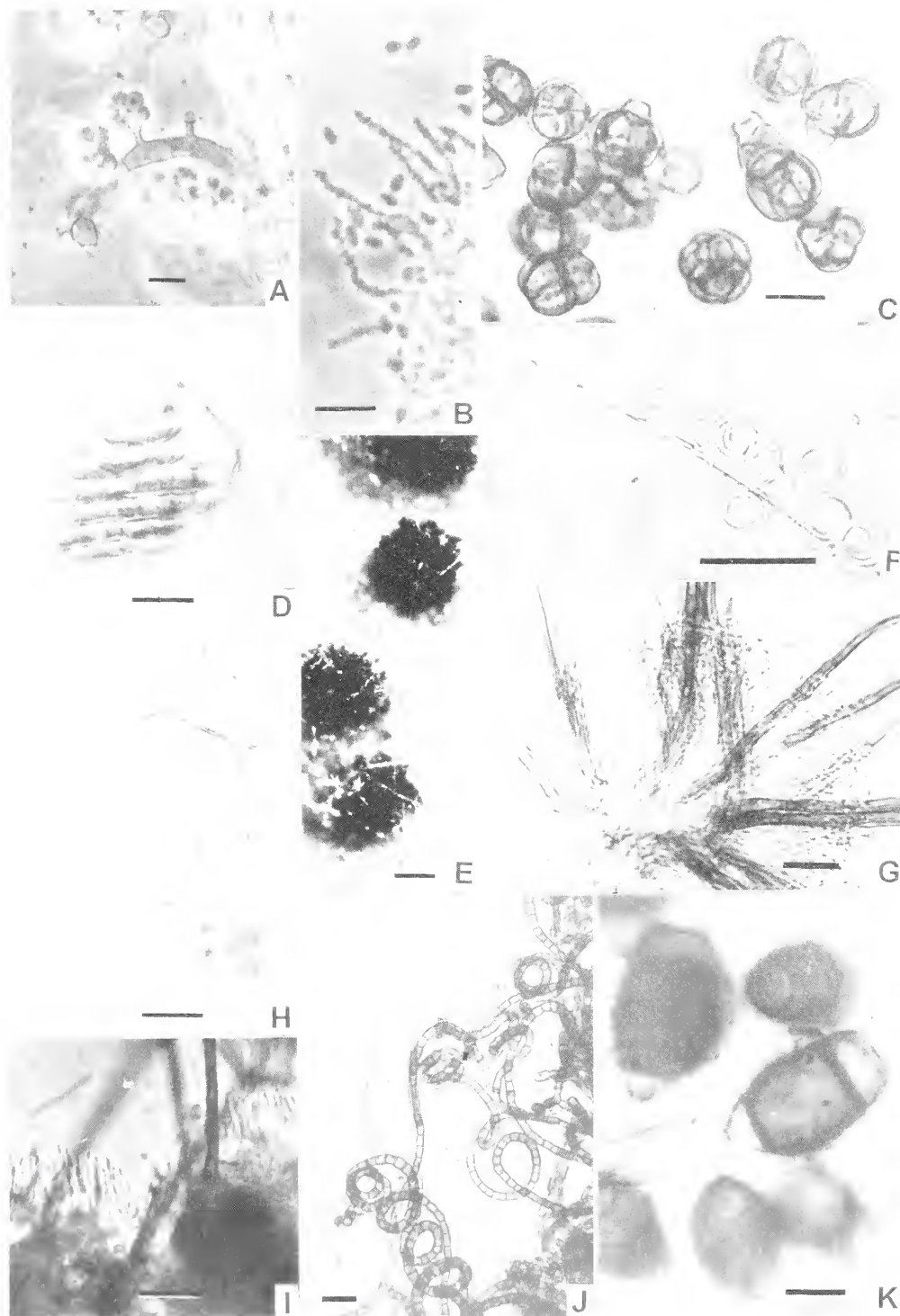


FIGURE 2.—Hyphomycetes from the fungal survey of the Karoo. A, *Cladorhynchium foecundissimum*: distinct collarette on phialide and conidia in mucilaginous ball; B, *Beauveria bassiana*: conidiogenous cells with denticles bearing conidia; C, *Cerebella andropogonis*: conidia with distinct basal pedicels; D, *Helicon sessile*: hyaline helicospore on slender conidiogenous cell; E, *Pithomyces chartarum*: conidia confined to ascostromata of *Leptosphaerulina chartarum* on blade of *Cynodon incompletus*; F, *Helicomycetes roseum*: hyaline helicospores on conidiophore; G, *Volutina concentrica*: coelomycete-like fungus with stipe, setae and conidia; H, *Gyrothrix flagella*: flagellum-like recurved setae in whorls; I, *G. flagella*: conidiogenous cells at bases of setae; J, *Taeniolella* sp.: characteristically curved conidia; K, *Curvularia tuberculata*: conidiogenous cell bearing conidium with tubercles. Scale bar: 50 µm.

could be opened for 10 minutes whereas 20 minutes in quiet conditions were needed to give the required results. A larger variety in fungal species was picked up in open patches than amongst dense undergrowth. On the lee side of bushes much fewer conidia could be collected. *P. chartarum* was collected in every Petri dish exposed.

2.2. Identification of fungi

The fungi were initially identified at magnifications of 25 × and 50 × using a Zeiss dissecting microscope. Verification of identifications was done with a similar make of research microscope. Material was mounted in lactophenol (Johnston & Booth 1983) but from 1980 the coelomycetes (mitotic fungi, Hawksworth *et al.* 1995) were mounted in ammonium hydroxide with 3.5% erythrosin (Sutton 1980) to facilitate identification based on conidiogenesis. Photomicrographs were obtained using an Olympus microscope camera and Ilford Pan F film.

The fungi were identified using standard monographs (Booth 1971; Ellis 1971, 1976; Subramanian 1971; Sutton 1980; Sivanisan 1987).

2.3. Meteorological data

Members of the Agricultural Meteorological Division of the Soils and Irrigation Research Institute stationed at Grootfontein recorded and monitored the weather from a casual station in the vicinity. This was equipped with a Stevenson Screen housing a thermohygrograph to record the daily minimum and maximum temperature, an anemometer, manual and automatic rainfall meters and a grass minimum thermometer.

2.4. Veterinary services

Veterinarians stationed at the Regional Diagnostic Laboratory of the Division of Veterinary Services inspected the sheep from time to time for clinical signs of 'geeldikkop'.

2.5. Flowering plants sampled

Tribulus terrestris L. (Zygophyllaceae): known as caltrop in the USA, three-cornered jack in Australia and also as Mexican sand-burr (Watt & Breyer-Brandwijk 1962); is notorious for causing disease in sheep and goats; is an annual pioneer plant with a sprawling habit which forms a ground cover; has composite leaves consisting of up to 11 small pinnae covered adaxially with long adpressed unicellular hyaline hairs.

Galenia sarcophylla Fenzl (Aizoaceae): a semisucculent, herbaceous ground cover with leaves covered with unicellular and multicellular hairs; is highly palatable to grazing animals and is preferred to *T. terrestris*; occupies a similar ecological niche as *T. terrestris*.

Galenia procumbens L.f. (Aizoaceae): a hardy erect shrub about 0.5 m high with small, smooth, simple leaves; is highly palatable to sheep.

Felicia muricata Thunb. (Asteraceae): a multistemmed perennial plant with simple, very small smooth leaves

with a sticky surface which serves as an ideal spore trap; is highly palatable to grazing animals.

Lycium cinereum Thunb. *sensu lato* (Solanaceae): an erect perennial plant, with woody branches which can reach a height of more than a metre; has simple, smooth leaves and produces small red berries after flowering in midsummer; in the young stages it is preferentially grazed but is shunned when older and harder, because of its thorny nature; when grazed heavily this species is similar to the smaller Karoo bushes.

Cynodon incompletus Nees (Poaceae): a stoloniferous perennial with a sprawling habit similar to *T. terrestris* and *G. sarcophylla*; under adverse conditions the plant is an annual.

Eragrostis lehmanniana Nees var. *lehmanniana* (Poaceae): an erect tussock grass which is intensively grazed; usually perennial but it may be annual under adverse conditions.

2.6. Sporidesmin assays

A total of 1005 isolates of *P. chartarum* were made for toxin production testing. Of these, 437 isolates were selected and grown on semisynthetic broth (Di Menna *et al.* 1970) for three weeks under near-UV and daylight fluorescent tubes on a 12 h/d cycle from a height of 300 mm at 20°C. The extraction procedure described by Marasas *et al.* (1972) was used.

3. RESULTS

3.1. Fungi recorded

3.1.1. From material directly planted out

All mycobiota identified during this survey are listed in the Appendix. Records of genera and species that were new for South Africa are marked.

The main groups and their incidence in relation to the seasons during the 1980/81 survey are given in Table 2. The total number of genera identified and the percentage representation of classes is given in Table 3. Tables 5, 6 and 7 give complete information regarding the percentage occurrence of the majority of identified fungi on particular substrates for the surveys from 1978 to 1981.

Some of the more unusual fungi identified have been illustrated in Figure 2 (Hyphomycetes) and Figure 3 (Coelomycetes). Conidia of *P. chartarum* localized on the ascstromata of *Leptosphaerulina chartarum* are especially noteworthy (Figure 2E).

Weather data recorded from October 1980 to April 1982 are shown on Figure 1. Seasonal fluctuations characterized most of the more prevalent fungi recorded. The seasonal incidences have been summarized in Table 2 where fungi which occurred continuously can be identified as having a peak in a particular season, e.g. summer or winter, as well as on what substrate they occurred. *P. chartarum* occurred frequently during the first years of

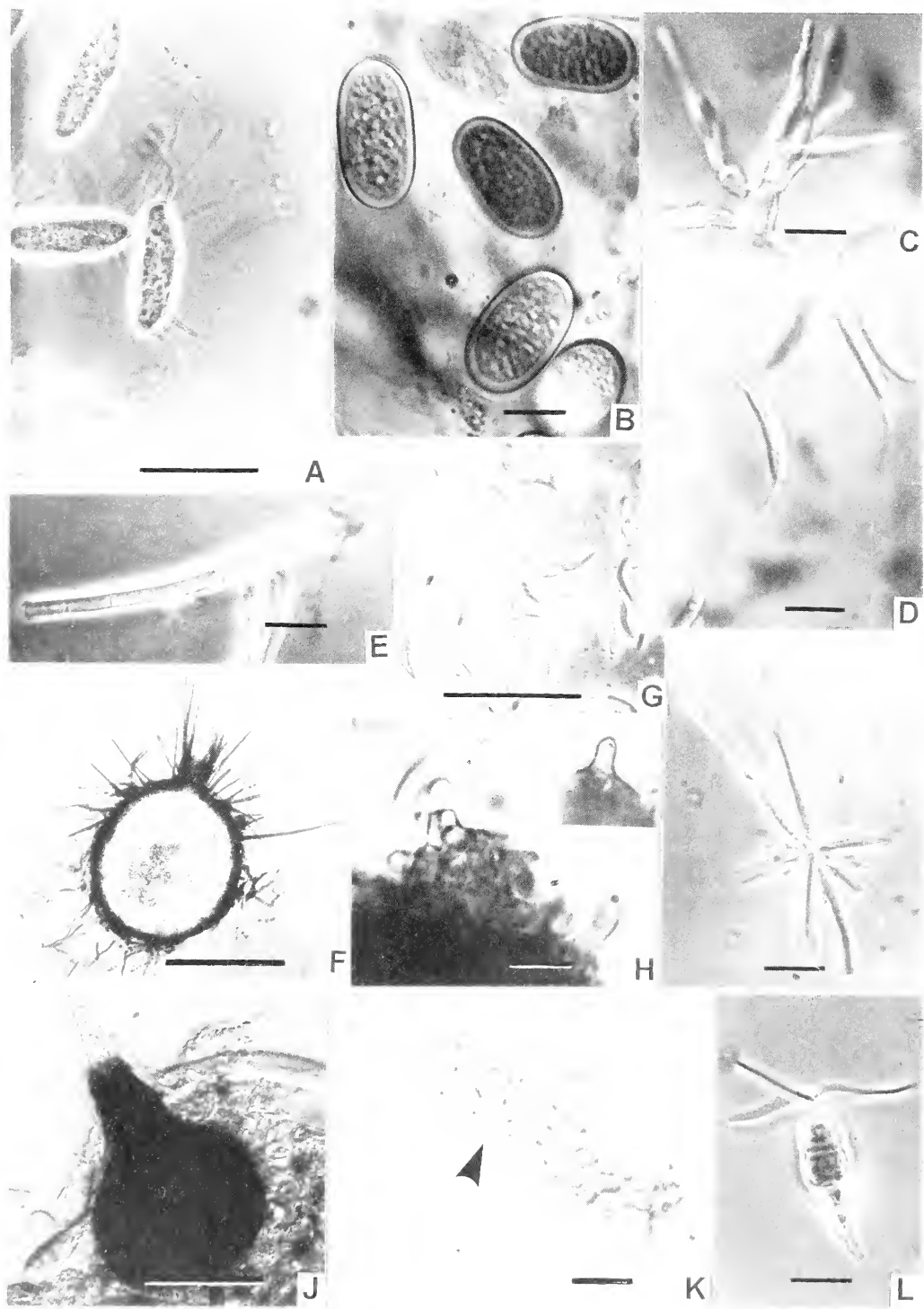


FIGURE 3—Coelomyces from the fungal survey of the Karoo. A, *Chaetosporium chaetosporum*: conidia with hilum and appendages on apical and basal ends of conidium; B, *Melanophoma* sp.: conidia with distinct epispor; C, *Dinemasporium* sp.: conidiogenous apparatus with collarette on phialide, base of conidium protruding; D, *Dinemasporium strigosum*: conidia showing apical and basal appendages; E, *Septoriella junci*: conidium with apical mucilaginous appendages and septa clearly visible; F, *Pyrenochaeta* sp.: longitudinal section through pycnidium showing setae surrounding ostiole; G, *Pseudoseptoria* sp.: falcate conidia; H, *Pseudoseptoria* sp.: conidiogenous cell showing developing conidia and (inset) characteristically long neck with multiple annellations; I, cf. *Tetranacrium* sp.: conidium with more than usual number of divergent arms; J, *Sarcinulella* sp.: pycnidium with characteristic tendril of conidia enveloped in a mucilaginous tube; K, *Sarcinulella* sp.: detail of conidial tendril with constriction caused by individual sac (arrowed); L, *Pestalotiopsis* sp.: conidium with apical three-armed appendage and single basal appendage. Scale bars: A, F, G, J, 50 μ m; B–E, H, I, K, L, 10 μ m.

TABLE 2.—Main groups of fungi recorded in the 1980/81 survey

Winter fungi	
<i>Alternaria</i> spp.	On <i>Lycium</i> in Camp A
<i>Aureobasidium</i> spp.	High on all substrates except <i>Tribulus</i> and litter
<i>Camarosporium</i> spp.	High on <i>Galenia procumbens</i> in Camp A
<i>Cladosporium</i> spp.	High on all substrates in Camp B
<i>Epicoccium purpurascens</i>	On <i>Cynodon</i> in Camps A & B
<i>Leptosphaerulina</i> spp.	Highest on <i>G. procumbens</i> in Camp B
<i>Rhizoctonia</i> spp.	High on litter from April onwards in Camp B
Autumn fungi	
<i>Fusarium</i> spp.	High on <i>F. muricata</i> and lower plants (Fig. 1) in Camp B
<i>Metarhizium anisopliae</i>	On all except <i>Tribulus</i> , <i>Cynodon</i> and <i>Felicia</i> in Camp A; disappeared after autumn in Camp B
<i>Myrothecium</i> spp.	Peak in late summer in Camps A & B; low on litter, peak on <i>Tribulus</i> in late summer in Camp A
<i>Leptosphaerulina</i> spp.	In Camp A low close to the soil on <i>Galenia sarcophylla</i> and litter; in Camp B high on <i>G. procumbens</i> ; lowest on prostrate plants, viz. <i>G. sarcophylla</i> and litter
Summer fungi	
<i>Camarosporium</i> spp.	Highest on <i>Galenia procumbens</i> , peak in mid-summer, consistent on litter in Camp B; different patterns on the different substrates; in Camp A, the lowest on litter all year round
No obvious pattern	
<i>Alternaria</i> spp.	On all substrates except <i>Lycium cinereum</i> in Camp B; slightly higher in winter in Camp A
<i>Mycosphaerella</i> spp.	Inconsistent on most substrates, high on <i>Lycium</i> in Camp B
Fungi always present	
<i>Drechslera</i> spp.	High on <i>Cynodon</i> , low but present on other substrates in Camps A & B
<i>Pithomyces chartarum</i>	Higher in Camp A; always present on all substrates but at very low levels
<i>Phoma</i> spp.	Consistent in Camp B; lowest on <i>G. procumbens</i> in Camp A
<i>Stauronema</i> spp.	Consistent on litter, peaks on <i>Felicia</i> , <i>Eragrostis</i> , <i>Cynodon</i> in Camp B; inconsistent in Camp A

the survey, reaching numbers of more than 80% but declined steadily as the drought continued. It could still, however, be isolated from material in each camp. *Galenia procumbens*, *Felicia muricata* and *Cynodon incompletus* were the hosts with the highest numbers of *Leptosphaerulina* sp. recorded throughout the 1980-1981 season, reaching peaks during the winter months. The weather kept to the same pattern over the entire survey and is shown in the record for the period October 1980 to April 1982 in Figure 1.

Average occurrences of the dominant fungi at the various sampling points and areas are presented for the Hyphomycetes (Figure 4), for the Coelomycetes and the genus *Leptosphaerulina* (Figure 5), the only ascomycete which occurred continuously for the periods 78/79, 79/80 and 80/81.

Sudden fluctuations can be attributed to personal sampling error when someone other than the regular sampler had collected the samples.

3.1.2. From material planted out after washing (Table 4)

P. chartarum does not, under normal circumstances, colonize living leaves in the Karoo and usually occurs as

superficial conidia on exposed plant surfaces. Surface sterilization is therefore not an appropriate technique when looking for this organism. However, the fact that it can occur as an endophyte would add another dimension to its versatility as it is already known as a pathogen of rice (Sutton & Gibson 1977) and a saprophyte.

3.2. Sporidesmin assays

A total of 36 isolates or 7.5% of the 1 005 isolates of *P. chartarum* was positive, and the highest yield was 40 mg/l sporidesmin. Most isolates, however, gave 10 mg/l or less sporidesmin under these conditions. The teleomorph *Leptosphaerulina chartarum* also produced 10 mg/l sporidesmin under the standard conditions.

3.3. Photosensitization

Although Merino sheep were kept in at least one sampling area at a time, no photosensitization on a clinical level was reported. This is supported by the weather data obtained, which confirmed that no 'danger period' for the outbreak of photosensitization had occurred according to the conditions given by Crawley & Woolford (1965).

TABLE 3.—No. of genera identified and percentage representation of classes during entire survey

Taxa*	No. of genera	% of total
Myxomycetes	4	3.25
Zygomycetes	5	4.07
Ascomycetes	11	8.94
Hyphomycetes	55	44.72
Coelomycetes	45	36.59
Mycelia Sterilia	3	2.44
Total	123	

* The Basidiomycetes were not included in the calculation because identification to genus level was not possible.

TABLE 4.—Percentage of pieces of plant material contaminated with *Pithomyces chartarum* after being washed thoroughly

Plant material	Camp A	Camp B
Plant litter	3.7	4.0
<i>Tribulus terrestris</i>	Not available	
<i>Cynodon incompletus</i>	2.0	2.8
<i>Eragrostis lehmanniana</i>	3.0	4.4
<i>Lycium cinereum</i>	6.0	2.4
<i>Galenia procumbens</i>	3.0	1.5
<i>Galenia sarcophylla</i>	9.3	16.0
<i>Felicia muricata</i>	0.6	4.0

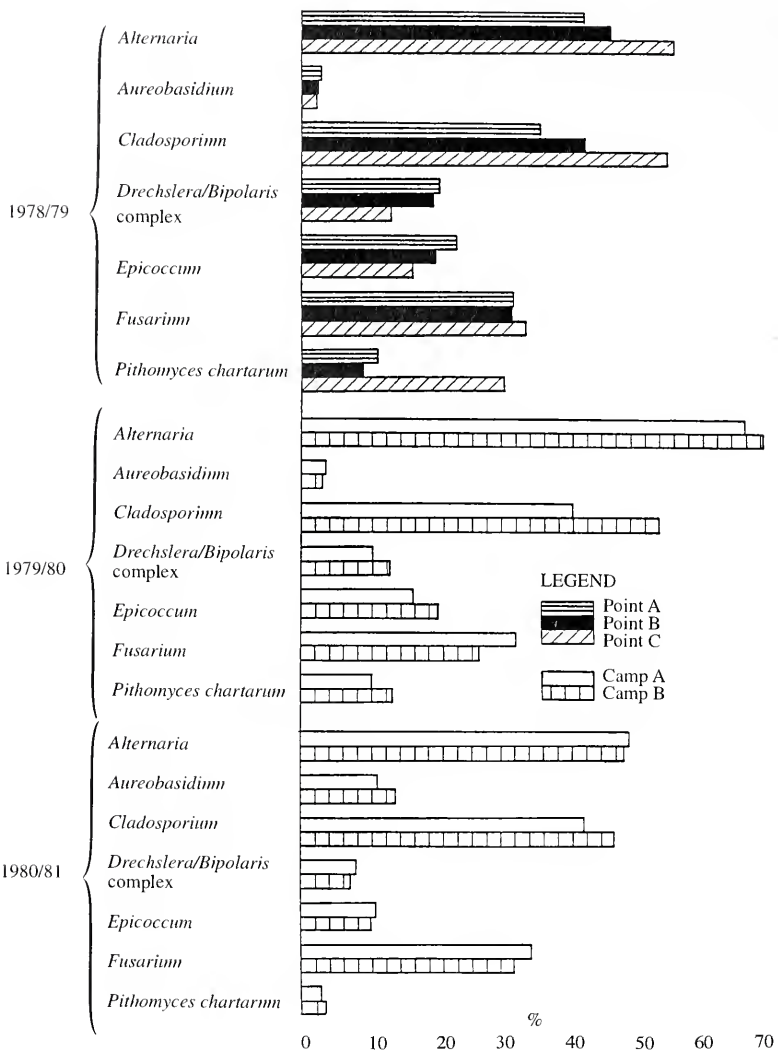


FIGURE 4.—Most prevalent Hyphomycetes recorded from 1978–1981.

4. DISCUSSION

4.1. Fungi recorded

A significant finding of this survey was that the Coelomycetes were abundant and diverse and that the number of genera found was nearly equal to that of the Hyphomycetes (Table 5). The 46 genera of identified Coelomycetes (Appendix) and 63 genera of the Hyphomycetes included 24 genera of the Coelomycetes and four genera and 14 species of Hyphomycetes newly recorded for South Africa (see Appendix). Two new records of Ascomycetes were noted, including one new species, *Leptosphaerulina chartarum* Ccc.Roux, which is the teleomorph of *Pithomyces chartarum* (Roux 1985a).

The total of 63 known genera of Hyphomycetes found in this survey is not as low as it would appear when compared with other surveys, for example that of Bezuidenhout (1977), which were done on either irrigated lands or under temperate conditions. The fungi in this survey were

collected under conditions not usually considered conducive to the maintenance of an extensive fungal population.

The fungi with consistently high counts were *Phoma* spp., *Alternaria alternata* and *Cladosporium* spp. (Figures 4 & 5). Pugh & Mulder (1971) also encountered *Alternaria tenuis*, *Aureobasidium pullulans*, *Cladosporium herbarum*, *Epicoccum nigrum* and *Phoma typharum* as initial colonizers of *Typha latifolia* L. Populations of *Phoma* spp. increased over the years which could be due to their being better adapted to the increasingly dry conditions. *Ascochyta* spp. and *Camarosporium* spp. increased with time and then levelled off. The incidence of *Bipolaris* spp. (including related genera such as *Drechslera* and *Exserohilum*), *Epicoccum nigrum* and *Pithomyces chartarum* declined over the study years, although these organisms still occurred consistently. The only Ascomycete which occurred consistently was the genus *Leptosphaerulina* which also declined eventually (Table 7). It is possible that *P. chartarum*, which was also present throughout the survey, could have been produced by *L. chartarum*, which was then counted as *P. chartarum* rather than as *L. char-*

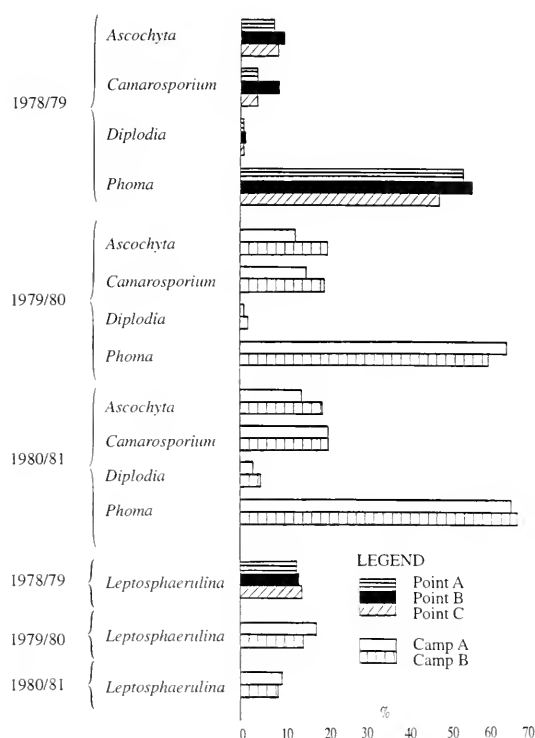


FIGURE 5.—Most prevalent Coelomycetes recorded from 1978–1981 including *Leptosphaerulina* spp., the only consistent Ascomycete.

tarum, when considering the nature of the sporulation straight from the ascospores. The correlation between the incidences of these two fungi, the ana- and teleomorph (mitotic and meiotic, Hawksworth *et al.* 1995) states, was therefore most significant.

The plant communities studied contain a wealth of fungi, many previously unrecorded. Noteworthy was the occurrence of albino strains of the common species *Alternaria alternata*, *Cladosporium cladosporioides* and *Stachybotrys chartarum*.

The Hyphomycetes (Table 5) occurred widely and were not as restricted regarding substrate as the other groups encountered. Unusually low incidences were, however, noted for species of *Aspergillus*, *Penicillium* and *Trichoderma*.

Coelomycetes (Table 6) recorded on a wide range of substrates were the following: *Ascochyta* spp., *Camarosporium* spp., *Diplodia* spp. and *Phoma* spp.

The highest incidence of the most prominent genera was noted during autumn and winter (Table 2). This could be explained by the fact that free water in the form of dew and rain was available for longer periods, thus enhancing the growth of fungi. Grass minimum temperatures recorded were substantially lower in winter than in summer. Highest rainfall occurred during late summer and autumn, seasons in which the wind tended to subside (Figure 1), thus reducing evaporation.

Nematophagous fungi, such as *Dactylella* and *Candelabrella* spp., were found. Large numbers of eelworms were inadvertently picked up with some of the samples and interfered with the counting of the fungi present on the substrate studied.

The entomophagous fungi *Beauveria bassiana* and *Metarhizium anisopliae* were frequently found but only in small numbers. *B. bassiana* is an important component of a complex of natural enemies of the Karoo caterpillar *Loxostege frustalis* Zeller (Möhr 1982). During the survey the Middelburg District experienced drought for three successive years. Consequently the ground cover decreased drastically and the unstable sandy soil was disturbed by wind and hoof action. The conidia of *B. bassiana*, associated with the early subterranean pupal stage of the karoo caterpillar, were therefore set free into the atmosphere in increasing numbers.

The increase in the number of species of Hyphomycetes from 1980 onwards can also be attributed to the worsening drought conditions which resulted in greater amounts of litter being deposited. The litter became very rich in fungi which would otherwise probably not have been isolated, as the litter fraction represented all the plant material available at the various sampling points and thus included all plant species not sampled separately. It is, therefore, understandable that mycobiota of litter should be much more varied than those of single plant species.

Aspergillus flavus deserves special mention. This toxigenic fungus was very common in animal feeds from all over South Africa examined for mycotoxigenic fungi during the entire survey period (Roux 1985b), but it was not recorded in the present survey during the normal rainy season of 1978/79.

In the initial trial run during which material was planted out after washing, *P. chartarum* was found to be an endophyte. This is even more significant in the light of the subsequent discovery of the teleomorph. Thus *P. chartarum*, or *L. chartarum* as it should now be known, can survive unsuitable conditions protected by the leaves of live plants and possibly sporulate when they die. The fact that the conidial stage of *L. chartarum* was found in tissues from all live plants studied is most significant.

Due to the large number of samples and the primary emphasis on *Pithomyces chartarum*, species of common genera such as *Fusarium*, *Bipolaris* and *Leptosphaerulina* were not recorded separately. The most common species of *Fusarium* was *F. moniliforme* followed by *F. subglutinans*. In the *Bipolaris* group the following species were identified: *B. cynodonis*, *B. halodes*, *B. hawaiiensis*, *B. papendorfii*, *B. zeicola*, *Drechslera phlei* and *Exserohilum rostrata*. *B. halodes* was the most prevalent.

Hering (1965) stated that though he had isolated a number of Ascomycetes and Coelomycetes, they failed to grow on the isolation medium. Experience obtained during this study showed that any bacteriostatic agent other than a few drops of lactic acid per Petri dish could completely inhibit the growth of some Coelomycetes. This could explain why the numbers of the Coelomycetes re-

TABLE 5.—Percentage of the total number of samples taken for the Hyphomycetes (1978–1981) (continued)

	1978/79 Samples taken: 15 700			1979/80 Samples taken: 4 050						1980/81 Samples taken: 28 600									
	Point A	Point B	Point C	Camp A			Camp B			Camp A			Camp B						
	In litter	In litter	In litter	In litter	Tribulus terrestris	Felicia muricata	Galenia procumbens	Galenia sarcophylla	Lycium cinereum	Cynodon incompletus	Eragrostis lehmanniana	In litter	Tribulus terrestris	Felicia muricata	Galenia procumbens	Galenia sarcophylla	Lycium cinereum	Cynodon incompletus	Eragrostis lehmanniana
Monacorsporium sp.	0.4	0.5	1.0	0.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Monilia sitophila	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Myrothecium spp.	-	23.9	17.8	3.7	40.0	3.7	7.8	15.6	0.7	25.2	7.0	2.6	5.2	12.1	4.7	33.2	4.5	21.0	14.5
Nigrospora oryzae	-	0.3	0.1	0.1	0.4	1.7	0.4	0.4	0.4	0.7	1.9	0.4	0.7	0.1	0.1	0.6	0.1	1.0	1.0
Oedocephalum sp.	1.2	1.5	-	0.4	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-
Paeclomyces sp.	0.2	0.1	0.1	0.4	-	-	-	-	-	-	-	-	-	1.0	0.2	0.1	0.1	0.2	0.1
Parapericonia augustii	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-
Penicillium spp.	0.7	0.8	1.4	0.3	0.4	1.7	0.4	0.7	0.4	1.5	0.7	0.7	0.4	3.4	3.8	2.1	2.5	0.9	3.7
Periconia spp.	4.0	0.2	9.9	0.1	7.1	3.0	-	3.4	3.3	2.2	-	0.4	1.1	3.3	0.4	0.1	0.2	0.7	0.9
Pithomyces	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
atro-olivaceus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
charitum	2.1	25.1	4.1	3.7	40.0	4.8	8.9	14.1	9.6	14.1	8.2	4.8	5.2	3.7	3.8	4.6	6.6	2.7	2.7
cynodontis	-	-	-	-	-	-	-	-	-	-	-	0.4	2.0	-	0.1	0.1	0.3	0.1	0.1
graminicola	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	0.1	-	-	-
karoo	0.5	0.1	0.2	1.3	0.2	0.8	-	-	-	-	-	-	-	0.4	-	0.1	0.3	0.5	0.4
maydicus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhinochloa spp.	1.3	1.1	2.1	0.4	-	0.7	0.4	-	0.4	0.4	-	0.4	-	2.0	-	0.1	0.1	1.0	0.3
Scopulariopsis brevicaulis	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	0.1	0.1	0.2	0.1	0.1
Spegazzinia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
parkeri	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
lessartha	0.4	0.1	0.5	0.4	-	0.7	0.4	-	0.4	0.4	-	0.4	0.1	0.1	0.4	0.1	-	0.2	0.1
Stachybotrys charitum	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	0.1	0.1	-	0.1	0.1
Stemphylium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
botryosum	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
vesicarium	0.2	-	0.6	3.0	-	-	-	-	-	-	-	4.1	-	0.3	0.2	0.1	0.4	0.7	-
Taeniolella spp.	3.0	1.1	0.8	-	-	-	-	-	-	-	-	-	0.4	0.6	-	-	-	0.2	-
Tetraploa ellisii	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-
Torula herbarum	0.3	1.8	0.4	3.0	-	-	-	-	-	-	-	-	-	0.1	-	0.1	0.1	-	-
Trichoderma sp.	0.3	-	-	0.8	-	-	-	-	-	-	-	0.4	-	1.7	1.8	0.8	1.3	1.2	-
Trichothecium roseum	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	0.7	0.1	-	0.1	0.1
Ulocladium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
attrum	0.2	0.2	-	-	-	-	-	-	-	-	-	0.4	-	-	-	-	-	-	-
charitum	0.1	0.1	0.7	0.4	16.7	-	-	-	-	-	-	-	-	0.1	0.1	0.1	0.1	0.1	0.1
Voluella colletotrichoides	1.5	0.7	0.4	1.9	-	8.9	18.9	1.5	4.1	-	-	-	-	0.2	4.0	1.4	1.0	0.9	0.8
Voluina sp.	0.3	0.1	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CR 20	0.1	-	0.1	-	-	-	-	-	-	-	-	1.2	-	-	-	-	-	0.1	0.2
Hyphomycete no. 1	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-	-

TABLE 6.—Percentage of the total number of samples taken for the Coelomycetes (1978–1981)

	1978/79 Samples taken: 15 700			1979/80 Samples taken: 4 050						1980/81 Samples taken: 28 600										
	Point A	Point B	Point C	Camp A			Camp B			Camp A			Camp B							
	In litter	In litter	In litter	In litter	Tribulus terrestris	Felicia muricata	Galenia procumbens	Galenia sarcophylla	Lycium cinereum	Cynodon incompletus	Eragrostis lehmanniana	In litter	Tribulus terrestris	Felicia muricata	Galenia procumbens	Galenia sarcophylla	Lycium cinereum	Cynodon incompletus	Eragrostis lehmanniana	
Amarosporium sp.	0.3	2.9	2.5	0.7	-	-	-	-	-	-	0.4	0.6	0.1	0.3	0.1	0.9	0.1	0.1	1.3	1.9
Ascochyta sp.	2.1	22.3	2.6	1.9	10.0	14.8	15.2	9.6	3.0	18.9	36.3	12.3	13.0	22.9	10.1	1.7	8.7	32.0	37.9	2.4
Bartalinia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Camarosporium sp.	0.4	8.9	1.3	0.4	6.7	7.0	61.1	64.8	4.8	1.9	1.1	-	-	-	-	-	-	-	-	-
Chaetodiplodia sp.	-	-	-	-	-	-	-	-	-	-	-	2.3	14.5	20.2	78.6	57.0	12.3	8.2	2.9	3.3
Chaetospermum sp.	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	8.5	-	-	-
Colletotrichum	-	-	-	-	-	-	-	-	-	-	-	0.4	-	-	-	-	-	-	-	-
coccodes	-	5.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
denatum	0.1	0.1	1.0	0.5	6.4	-	-	-	-	-	-	-	24.8	0.3	-	7.4	-	-	0.1	0.4
gloeosporioides	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
graminicola	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coniothyrium sp.	-	-	-	-	-	-	-	-	-	-	-	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.6	0.2
Dinemasporium sp.	7.0	-	1.3	2.2	0.4	0.4	0.4	0.4	0.4	0.4	1.5	0.9	0.9	0.1	0.3	0.1	0.1	0.3	0.1	0.3
Diplodia spp.	1.2	1.2	1.4	0.9	1.2	1.3	0.4	13.3	0.7	4.1	1.5	2.4	3.1	6.8	2.2	1.7	8.2	3.4	2.1	27.3
Eriospora sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eriosporella sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gelatinospora sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hendersonia sp. 1	0.6	0.2	0.4	0.2	-	3.7	-	-	-	-	-	0.4	13.3	-	-	-	-	0.6	0.1	0.2
Hendersonia sp. 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Idiocercus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Macrophomina sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Melanconium sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Melanophoma sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Neottosporina spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pestalotiopsis spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phoma spp.	34.9	90.5	34.9	85.6	40.9	70.3	90.4	78.3	88.8	54.4	80.6	64.8	59.3	78.9	85.2	-	73.7	53.0	85.6	53.7
Phomopsis spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pleurothyrium sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polynema sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pseudoseptoria sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyrenochaeta spp.	1.0	1.8	3.3	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Septoria spp.	-	0.3	0.5	0.3	0.1	-	0.7	-	-	-	-	0.4	3.3	0.3	0.1	0.1	0.1	0.2	0.1	7.2
Septoriella sp.	1.5	-	1.8	1.4	-	-	-	-	-	-	-	-	0.2	-	0.1	0.5	0.5	2.9	3.4	4.8
Sphaeropsis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Siagonospora sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stauronema sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tetranacrium sp.	0.6	0.1	0.6	0.4	-	4.1	-	-	-	-	-	3.9	0.2	0.6	0.1	0.2	0.1	0.9	2.9	3.8
Tiarosporiella sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tribliopycnis sp.	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-
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ported in other surveys of fungal populations are negligible.

Dickinson (1967) could correlate an increase in frequency of *Stemphylium botrysom* with records of its perfect state, *Pleospora herbarum*, on *Pisum* leaves. In the present survey the relation between *Leptosphaerulina chartarum* and its anamorph only became clear after conclusion of the sampling programme. All specimens of *Leptosphaerulina* were not identified to species level. It can, however, be assumed that *L. chartarum* was more prevalent at times when incidences of *Pithomyces chartarum* reached peaks, e.g. late summer and early winter (February to May), seeing that *P. chartarum* and *Leptosphaerulina* spp. were more prevalent then.

4.2. Photosensitization

Crawley & Woolford (1965) stipulated a minimum temperature of 12.2°C or more on three consecutive days together with 3.76 mm of rain as a danger period for the development of the facial eczema in sheep. The same conditions were assumed to be necessary for the development of 'geeldikkop' in local sheep. No such conditions were recorded and no cases of photosensitization on the sampled pastures were reported.

Another factor which could play a role was the presence of saponins in the *T. terrestris* plants (Watt & Breyer-Brandwijk 1962). Aas & Ulvund (1989) speculated that *P. chartarum*, especially the sporidesmin present on bog asphodel and saponins, may be involved in the aetiology of alveld (a hepatogenous photosensitivity) in Norway. Since then, Kellerman *et al.* (1991) have shown that saponins on their own are able to induce hepatogenous photosensitivity in some sheep. The importance of sporidesmins has, however, not diminished as all sheep in that trial did not react positively. Kellerman *et al.* (1991) found that fresh *T. terrestris*, both on its own and with sporidesmin, caused 'geeldikkop' in sheep.

5. CONCLUSIONS

The survey highlights the wealth and variety of fungi found in this inhospitable environment. The large numbers of genera found is due to the wide range of materials sampled. A peculiarity was that virtually the same number of genera of Coelomycetes and Hyphomycetes was found. Nag Raj (1981) noted that Coelomycetes were more prevalent in dry climates, a fact which has been confirmed here. This phenomenon can be attributed to the adaptation of the fungus in shielding its conidiogenous cells and hyaline conidia from the high UV-radiation in the predominantly cloudless Karoo region by developing a conidioma. Very few synnematous genera of the Hyphomycetes were recorded. An analogue in the Hyphomycetes is the protective mechanism of melanin, because a great proportion of the species present have melanized conidia.

This is the first survey in southern Africa in which such a high proportion of fungi identified belonged to the Coelomycetes. The individual genera could be determined to a great extent using Sutton's keys (1980). Numerous new records for South Africa were registered.

The suitability of litter as a substrate for fungal growth, even under these harsh climatic conditions, was an indication of the role fungi play as agents in the breakdown of organic matter. The wide spectrum of fungal genera noted on the litter gave an indication of what was present on substrates not sampled separately.

This survey demonstrated the persistent presence of *Pithomyces chartarum* on various substrates in the Karoo. This is a very important finding in view of its toxicity. The teleomorph of this fungus, *Leptosphaerulina chartarum*, was found during this study (Roux 1985a). *P. chartarum* was recovered from *T. terrestris* leaves without lesions. This possible endophytic symbiosis of certain strains may indicate its mycotoxicological, opposed to pathogenic (Haware & Sharma 1973) nature and also of the existence of purely saprophytic strains. This survey illustrates the importance of intensive studies of fungal populations.

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APPENDIX—Complete list of fungal taxa identified

The actual fungus which was recorded is cited, not the sexual phase (teleomorph) if it was not found, as is recommended in the Rules of Nomenclature. *New genera for South Africa. **New species for South Africa

HYPHOMYCETES

- Acremoniella
 atra (Corda) Sacc.
 verrucosa Tognini
- Alternaria
 alternata (Fr.) Keissl.
 zinniae M.B.Ellis
- Arthrobotrys superba Corda
- Arthrinium saccharicola (Speg.) M.B.Ellis
- Aspergillus
 candidus Link
 flavus Link
 nidulans Eidam
 niger Tiegh.
 terreus Thom
 spp.
- Aureobasidium
 pullulans (de Bary) Arnaud
 spp.
- Beauveria bassiana (Bals.-Criv.) Vuill.
- Bipolaris
 cynodontis (Marigoni) Shoemaker
 hawaiiensis (M.B.Ellis) Uchida & Aragaki
 papendorfii (Aa) Alcorn
 zeicola (Stout) Shoemaker
- Botrytis
 state of Sclerotinia fuckeliniana (de Bary) Fuckel
 sp.
- Candelabrella sp.
- Cephalosporium sp.
- Cercospora sp.
- Cerebella andropogonis Ces.
- Chrysionilia sitophila (Mont.) Arx (= Monilia sitophila Mont.)
- Cladorthium foecundissimum Sacc. & E.J.Marchal

- Cladosporium
 cladosporioides (Fresen.) G.A. de Vries
 herbarum (Pers.) Link
 variable (Cooke) G.A. de Vries
 spp.
- Curvularia
 lunata (Wakker) Boedijn
 tuberculata B.L. Jain**
- Dactylella sp.
- Dichotomophthora portulacae Melrl. & Fitzp. ex M.B. Ellis*
- Doratomyces
 stemonites (Pers. ex Fr.) F.J. Morton & G. Sm.
 phlei (Graham) Shoemaker
- Epicoccum nigrum Link
- Exserohilum rostrata Leonard & Suggs
- Fusariella cf. obliqua (Pollack) S. Hughes
- Fusarium
 acuminatum Ellis & Everh. sensu Gordon
 equiseti (Corda) Sacc. sensu Gordon
 moniliforme E. Sheldon
 semitectum Berk. & Ravanel
 stoveri Booth**
 subglutinans (Wollenw. & Reinking) P.E. Nelson, Toussoun & Marasas
- Gliocladium
 penicillioides Corda
 roseum Bainier
- Gonatobotrys simplex Corda
- Graphium penicillioides Corda
- Gyrodactylus flagella (Cooke & M.B. Ellis) Piroz**
- Helicomyces roseus Link
- Helicium sessile Morgan**
- Hyalodendron lignicola (Diddens) de Hoog
 cf. Lacellina macrospora (Berk. & Broome) Petch**
- Memnoniella echinata (Rivolta) Galloway
- Metarhizium anisopliae (Metsch.) Sorokin
- Monacrosporium sp.
- Monascus sp., conidial state
- Moniliella sp.**
- Myrothecium
 carmelii Grev.
 cinctum (Corda) Sacc.**
 roridum Tode ex Fr.
 verrucaria (Alb. & Schwein.) Ditmar ex Fr.
- Nigrospora state of Khuskia oryzae H.J. Huds.
- Oedocephalum glomerulosum (Bull.) Sacc.**
- Paecilomyces sp.
- Parapericonia angusii M.B. Ellis*
- Penicillium
 chrysogenum Thom
 oxalicum Currie & Thum
 spp.
- Periconia
 byssoides Pers. ex Mérat
 cookei E.W. Mason & M.B. Ellis
 cf. madreya Subram.
- Pithomyces
 atro-olivaceus (Cooke & Harkn.) M.B. Ellis
 chartarum (Berk. & M.A. Curtis) M.B. Ellis
 cynodontis M.B. Ellis
 graminicola R.Y. Roy & B. Rai
 karoo Marasas & Schumann
 maydicus (Sacc.) M.B. Ellis**
 sacchari (Speg.) M.B. Ellis
- Pyricularia oryzae Cavara
- Rhinocladia
 state of Dictyotrichiella mansonii Schw.-Schwartz
 cellaris (Pers. ex Gray) M.B. Ellis**
- Scopulariopsis brevicaulis (Sacc.) Bainier
- cf. Septofusidium elegantulum (Pidopl.) W. Gams
- Spegazzinia
 cf. parkeri Sivan,**
 tessartha (Berk. & M.A. Curtis) Sacc.
- cf. Sporidesmium Link*
- Stilbella spp.
- Stachybotrys
 chartarum (Ehrenb.) S. Hughes
 sansivieriae Agarwal & Sharma**
- Stemphylium
 state of Pleospora herbarum (Pers. ex Fr.) Rubenb.
 vesicarium (Wallr.) E.G. Simmons
- Taeniocella*
 scripta (Karst.) S. Hughes**
 sp.**
- Tetraploa ellisii Cooke
- Torula herbarum (Pers.) Link ex Gray
- Trichoderma
 harzianum Rifai
 sp.
- Trichothecium roseum (Pers.) Link
- Trichurus spiralis Hasselbr.
- Ulocladium
 atrum Preuss
 chartarum (Preuss) E.G. Simmons
 tuberculatum E.G. Simmons**
- Volutella colletotrichoides J.E. Chilton
- Volutina*
 concentrica Penz. et Sacc.**
 sp.**
- Albino fungi**
- Alternaria alternata (Fr.) Keissl.
- Cladosporium cladosporioides (Fresen.) G.A. de Vries
- Stachybotrys chartarum (Ehrenb.) S. Hughes
- COELOMYCETES**
- Amerosporium concinnum Petr.
- Ascochyta sp.
- Ascochytiella sp.*
- Bartalinia robillardoides Tassi*
- Camarosporium
 quaternatum (Hanzl.) Schulz**
 spp.
- Chaetodiplodia sp.*
- Chaetosporium chaetosporum (Pat.) A.L. Sm. & Ramsb.*
- Colletotrichum
 coccodes (Wallr.) S. Hughes
 dematium (Pers. & Fr.) Grove
 gloeosporioides (Pers.) Sacc.
 graminicola (Ces.) G.W. Wilson
- Coniothyrium
 fuckelii Corda
 sp.
- Dinemasporium*
 strigosum (Pers. ex Fr.) Sacc.**
 spp.**
- Diplodia sp.
- Eriospora leucostoma Berk. & Broome*
- Eriosporella sp.*
- Gelatinosporium sp.
- Hendersonia sp.
- Idiocercus macarangae (T.S. Ramakr.) B. Sutton*
- Jahniella sp.*
- Libertella sp.
- Macrophoma phaseolina (Tassi) Goid.
- Melanconium sp.
- Melanophoma
 karoo Papendorf & J.W. du Toit
 sp.**
- Microsphaeropsis sp.
- Neottiosporina masonii B. Sutton apud B.C. Sutton & Marasas*
- Pestalotiopsis
 guepinii (Desm.) Stey.
 sp.
- cf. Phacidiella sp.*
- Phaeoseptoria sp.*
- Phoma
 epicoccina Punit., M.C. Tulloch & C.M. Leach**
 glomerata (Corda) Wollenw. & Hocht.
 sorghina (Sacc.) Boerema, Dorenb. & Kesteren
 sp.
- Phomopsis sp.
- Pleurothyrium longissimum (Lib.) Bubák*
- cf. Pleurothyrium sp.*
- Polynema sp.*
- Polystigmata rubrum (Desm.) Sacc.*
- Pseudoseptoria sp.*
- cf. Pycnosporella sp.*
- Pycnochaeta sp.**

Sarcinulella cf. banksiae *B.Sutton & Alcorn**
Seimatosporium sp.*
Septoria sp.
Septoriella*
 junci (*Desm.*) *B.Sutton***
 sp.**
Sphaeropsis sp.
Stagonospora sp.
Staurostoma spp.*
 cf. Tetranacrium gramineum *H.J.Huds. & B.Sutton**
Tiarosporella graminis (*Piroz. & Shoemaker*) *Nag Raj* var. karoo *B.Sutton & Marasas*
Tryblidiopycnis sp.*
Urohendersonia platensis *Speg.**

MYCELIA STERILIA (Agonomycetes)

Papulospora sp.
Rhizoctonia sp.
Sclerotium rolfsii *Sacc.*

ZYGOMYCETES—Mucorales

Actinomucor elegans *Shostakowitz*
Cunninghamella echinulata (*Thaxt.*) *Thaxt.*
Mortierella sp.
Mucor sp.
Rhizopus stolonifer (*Ehrenb.:Fr.*) *Vuill.* var. stolonifer
Rhizomucor spp.

ASCOMYCETES

Ascotricha sp.
Ceratocystis sp.

Chaetomium
 globosum *Kunze*
 sp.
Leptosphaeria spp.
Leptosphaerulina
 briosiana (*Poll.*) *J.H.Graham & Luttrell*
 chartarum *Cec.Roux***
Mycosphaerella
 tassiana (*De Not.*) *Johanson*
 sp.
Ophiobolus sp.
Pezizales (unidentified)
Platyspora permunda (*Cooke*) *Wehm.* = *Comoclathris* *Clem.***
Pleospora
 herbarum (*Pers. ex Fr.*) *Rabenh.*
 sp.
Saccobolus minimus *Vel.*
Sordaria fimicola (*Roberge*) *Ces. & De Not.*

BASIDIOMYCETES

Agaricales
Aphyllorphorales
Coprinus spp.
Puccinia graminis *Pers.*
Ustilaginales

MYXOMYCETES

Didymium sp.
Physarum cinereum (*Batch.*) *Pers.*
cf. Reticularia sp.
Stemonitis cf. smithii *T. Macbr.*

A floristic classification of the vegetation of a forest-savanna boundary in southeastern Zimbabwe

I. MAPAURE*

Keywords: classification, Detrended Correspondence Analysis, forest-savanna boundary, moist forest, savanna, TWINSpan, vegetation type, Zimbabwe

ABSTRACT

The vegetation of Chirinda Forest boundary was classified into eight types using Two-way Indicator Species Analysis (TWINSpan) and Detrended Correspondence Analysis (DCA). The moist forest comprises three types: *Strychnos mello-dora*–*Chrysophyllum gorungosanum* Forest on deep dolerite soils; *Chrysophyllum gorungosanum*–*Myrianthus holstii* Forest on shallow dolerite soils; and *Teclea nobilis*–*Ehretia cymosa* Forest on drier, but deep dolerite soils. The non-forest vegetation comprises five types: *Themeda triandra* Grassland on shallow dolerite soils; *Psidium guajava* Bushland on sandstone; *Bridelia micrantha*–*Harungana madagascariensis* Mixed Woodland not restricted to any one particular soil type; *Acacia karroo*–*Heteropyxis dehniae* Woodland on shallow soils derived from sandstone but sometimes on dolerite; and *Julbernardia globiflora*–*Brachystegia spiciformis* (Miombo) Woodland on sandstone.

INTRODUCTION

Forest patches occur in many tropical countries, often embedded in a matrix of non-forest vegetation types, forming unique units along their boundaries. Ranney *et al.* (1981) emphasized the importance of forest fringes in the structure and dynamics of forest patches. The boundary creates microclimatic gradients that result in differences in environment between the forest interior and the outside, non-forest areas. In this context, the influence of soil moisture and other edaphic changes at the forest-savanna boundary is particularly important (Furley 1992; Hopkins 1992).

The ecotone between forest and non-forest areas often has high plant densities and diversity, and represents the juxtaposition of two contrasting habitats. Along the ecotone there is generally a high incidence of wind and animal activity, especially mammals and frugivorous birds. As a result, the predation of seed and fruit and the opportunity for their dispersal are both enhanced.

In Zimbabwe, forest patches with sharp boundaries between them and non-forest vegetation are common along the eastern highlands where three main centres of moist forest development can be identified, namely the Nyanga, the Vumba and the Chimanimani massifs. Many other smaller patches of forest occur elsewhere, including Chirinda, the area of this study. The factors responsible for these boundaries vary from place to place, but fire, altitude and edaphic factors are among the most important. Crook (1952) and Phipps & Goodier (1962) discussed the vegetation patterns of the Chimanimani Mountains, with emphasis on the determinants of the forest, woodland, grassland and Ericaceous scrub. Similar situations can also be encountered in the Vumba, Nyanga and Chirinda areas.

Inventories of the vegetation of Chirinda Forest have been compiled by, among others, Goldsmith (1976) and Muller (1991). Much of this work focused mainly on the moist forest proper, with very little attention paid to the surrounding non-forest vegetation. Mapaure (1993) discussed the factors influencing the vegetation of the forest boundary whilst Timberlake *et al.* (1994) described the composition of the forest and some ecological factors affecting the vegetation. A list of flowering plants and ferns found in and around the forest has been compiled by Drummond & Mapaure (1994).

The main objective of this study was to inventory the woody vegetation of Chirinda Forest boundary, including adjacent bushland, grassland and woodland areas and to produce a classification and description of the vegetation types.

STUDY AREA

The study was carried out in Chirinda Forest, situated near Mount Selinda Mission (20° 25'S, 32° 43'E) in south-east Zimbabwe (Figure 1). The forest represents the southern end of moist forest distribution in Zimbabwe and is the best preserved example of medium altitude moist forest (Muller 1991). It is surrounded by pine plantations, Mission settlements, Chako Business Centre, and commercial farmlands. It is a gazetted Forest Land managed by the Forestry Commission, covering 947 ha, of which 606 ha is moist evergreen forest. The forest lies on two broad highlands rising from 1 076 m to 1 250 m in altitude. These form two crests, essentially subdividing the forest into two, a northern and a southern section with a narrow forested saddle in between.

The geology of the area comprises red and purple phyl-litic mudstones interbedded with pale fine- to medium-grained feldspathic sandstones of the Upper Argillaceous series of the Precambrian Umkondo System (Watson 1969). Fine-grained dolerite sills have intruded into these sandstones, forming a cap over much of the higher

* Department of Biological Sciences, University of Zimbabwe, P.O. Box MP 167, Mount Pleasant, Harare, Zimbabwe.
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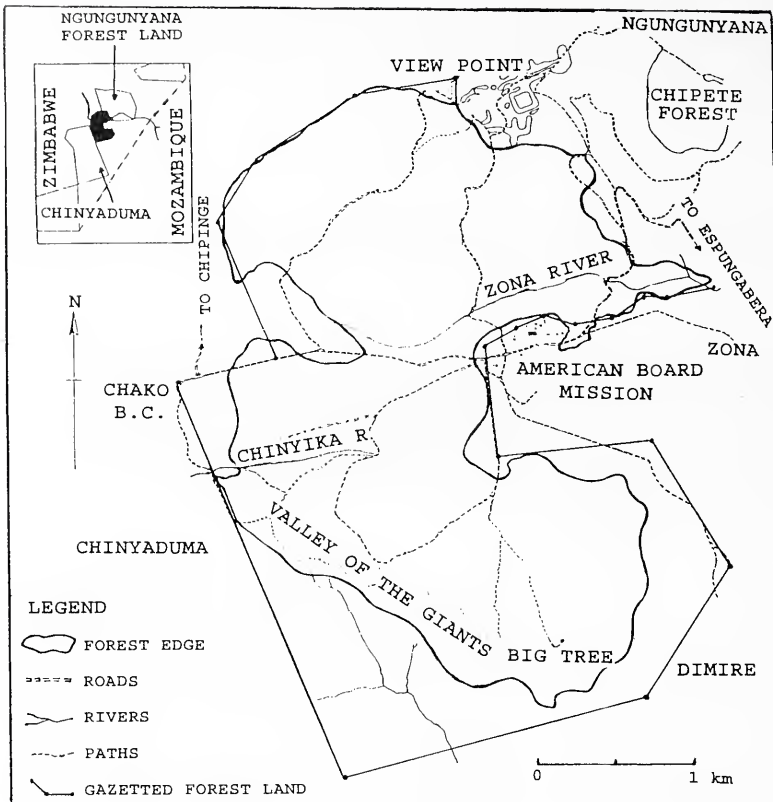


FIGURE 1.—Location of Chirinda Forest in southeastern Zimbabwe.

ground. The moist forest is generally found on dolerite soils.

The area receives an average rainfall of 1 470 mm per annum (Anon. 1977). Average winter and summer temperatures are 14°C and 20°C, respectively (Sayce 1987). The prevailing winds are southeasterly.

METHODS

An interpretation of 1:12 500, black-and-white aerial photographs of 1987 was carried out and stratification of the vegetation around the forest was done, based on the textural differences on the photographs. A map was produced based on both the interpretation of the aerial photographs, which aided in the marking of the boundaries of the vegetation types, and field sampling.

Ten belt transects (two through each of the five vegetation units apparent on the aerial photographs), each 200 m long and 20 m wide, were established (Figure 2A–J) so that half the distance was in the forest and the other half in the non-forest vegetation. The edge of the forest was identified by either an obvious noticeable change in species composition or by a difference in vegetation structure, or both. Each belt transect was subdivided into ten 20 × 20 m contiguous quadrats, five on either side of the forest boundary, resulting in a total of 100 quadrats. The appropriateness of this quadrat size was confirmed by a species-area curve.

In each quadrat, the woody species were identified and assigned to height classes as follows: seedlings, saplings (< 0.5 m), understorey (0.5–3.0 m), subcanopy trees (3–10 m), and canopy trees (> 10 m). An overall cover-abundance value for each woody species in each quadrat was assessed following the Braun-Blanquet scale (Mueller-Dombois & Ellenberg 1974). Climbers were rated separately according to the number of stems encountered in the stands rather than for a cover value.

Soil depth was determined by augering six quadrats per transect, three on either side of the forest edge. The soils were considered deep if no rocks were encountered down to a depth of 80 cm. The geology was determined from any exposed bedrock and by reference to the geological map of the area.

Data analysis

Vegetation data were analysed using Two Way Indicator Species Analysis (TWINSPAN) (Hill 1979) and Detrended Correspondence Analysis (DCA) (Gauch 1982). TWINSPAN was applied on the full species data set, consisting of 261 plant species belonging to 204 genera and 76 families and DCA was applied on the sixty quadrats from which soil data were collected. Rare species were downweighted and for pseudospecies cut-levels of 0, 1, 3 and 5 were used in the application of TWINSPAN. Cover-abundance values of species were used in both analyses. Minor refinements were done to the TWINSPAN output (Table 1) to improve its clarity, especially the removal,

after analysis, of the species which occurred three times or less (except indicator species) and lianes and vines.

RESULTS AND INTERPRETATION

Vegetation classification

Eight vegetation types were identified (Figures 3 & 4) on the basis of the TWINSpan and DCA analyses. The primary division of the stands by TWINSpan separated out the moist forest stands from non-forest (woodland and grassland) stands. The second level of division separated out forest stands in the northwestern part of the forest from the rest of the forest stands. These forest stands (Type III) are situated close to the miombo stands, on the drier side of the highland. The third level of division further subdivided the remaining forest stands into a group which occurred in the eastern to southeastern part of the forest (mainly transects E, F, G and H) (Type II). The other group (Type I) consists mostly of forest stands from transects A, B, C and D. The forest stands, therefore, fall into three main types.

Among the non-forest vegetation stands, the second level of division separated out grassland stands, which occurred in the southeastern part of the forest (Type VII), from the rest of the non-forest vegetation. The remaining non-forest stands were divided into a further two groups at the third level of division. One type (Type IV), which consists of a wide mixture of stands from several transects but close to the apparent forest edge, was separated from the rest of the remaining non-forest vegetation. The remaining stands were further divided into two, one of which comprises two types. Type VI consisted of stands mainly from an area close to Chako Business Centre (the sandstone enclave) and stands from the northwestern side forming Types V and VIII. Further subdivision of these types was considered unnecessary because the number of stands in each group was too small to justify the subdivision.

The forest, woodland and grassland types were clearly separate, with some ubiquitous intermediary vegetation types bridging them. Within the three moist forest vegetation types, two were not clearly separated on the basis of species composition but were strongly differentiated on

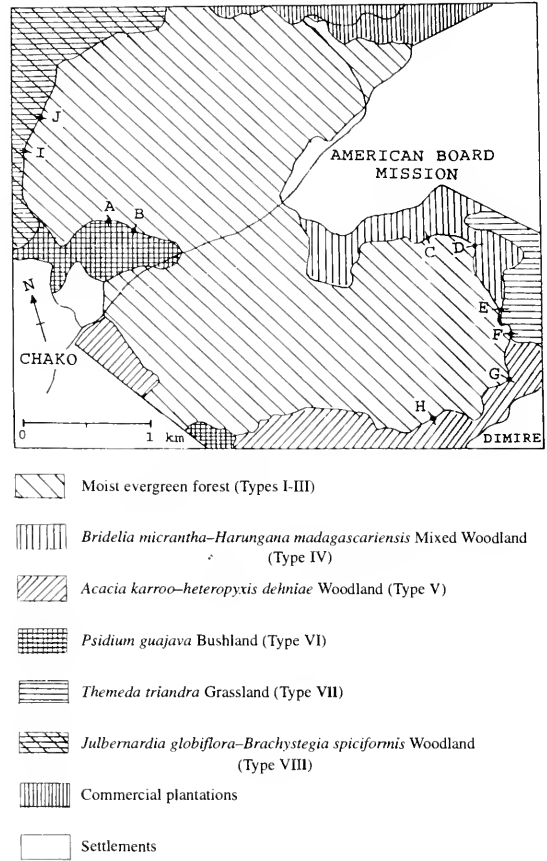


FIGURE 2.—A map showing the major vegetation types in Chirinda Forest area. The positions of the transects (A-J) are indicated.

the relative dominance of the species in the upper canopy and subcanopy strata. *Strychnos mellodora*, *Rothmannia urcelliformis*, and *Chrysophyllum gorungosanum* had higher cover abundance values (averaging about 50%) in forest Type I than in forest Type II, where they averaged 20%. *Myrianthus holstii* had a lower cover value (about 10%) in forest Type I than in Type II (about 25%). Forest Type III occurred in a drier area, had a more open canopy and,

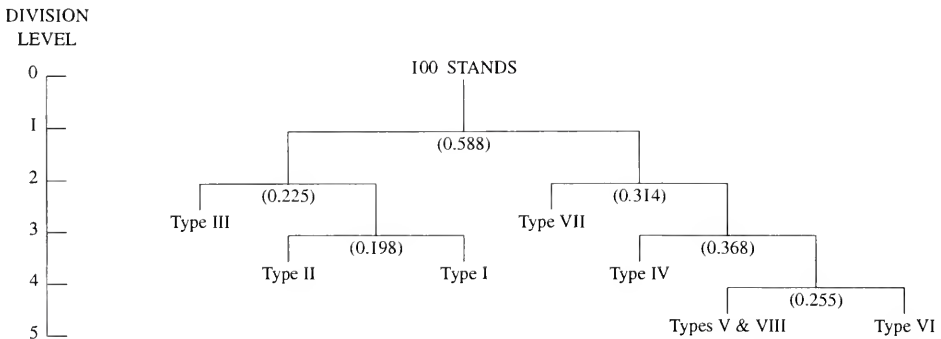


FIGURE 3.—Dendrogram showing the TWINSpan results of the quadrats in Chirinda Forest (eigenvalues are shown in brackets).

TABLE 1.—A synoptic table of TWINSPLAN classification of Chirinda Forest vegetation. Full names of species indicated by mnemonics are given in Appendix 1

Stand number												
1												
2223347111237 1 344445556566677 89908891237 5 1177889 222333334444567266677999 6888889992 111 4555												
78908090890987897 76789067689078907 078908906666 56453467645345123452345455223412345 112345121 123123 1123												
CEL MIL	---	21-1-12---	---	1-----	---	1-----	---	1-----	---	1-----	---	1-----
STR USA	111111-11211-122-1	11211-1-1-1-1-1	1-1-121	1-1-121	1-1-121	1-1-121	1-1-121	1-1-121	1-1-121	1-1-121	1-1-121	1-1-121
STR MEL	22-233-34333-3444	2-111-1-1-1-1-1	1-1-1222	2-111-1222	2-111-1222	2-111-1222	2-111-1222	2-111-1222	2-111-1222	2-111-1222	2-111-1222	2-111-1222
RIN FER	---	2-1-1-1-1-1-1	---	2-1-1-1-1-1-1	---	2-1-1-1-1-1-1	---	2-1-1-1-1-1-1	---	2-1-1-1-1-1-1	---	2-1-1-1-1-1-1
PLE PWC	111-2-1-1-1-1-1	1-111-2-1-1-1-1	1-111-2	1-111-2	1-111-2	1-111-2	1-111-2	1-111-2	1-111-2	1-111-2	1-111-2	1-111-2
HEI DIE	23222211-11-1-1	211-21322232111-1	1-11-1-1-1	1-11-1-1-1	1-11-1-1-1	1-11-1-1-1	1-11-1-1-1	1-11-1-1-1	1-11-1-1-1	1-11-1-1-1	1-11-1-1-1	1-11-1-1-1
STR SCH	13321211-21-1-1	211-1212112212121-1	1-1-1-1-1	1-1-1-1-1	1-1-1-1-1	1-1-1-1-1	1-1-1-1-1	1-1-1-1-1	1-1-1-1-1	1-1-1-1-1	1-1-1-1-1	1-1-1-1-1
CHI BAT	221-1-1-1-1-1-1	21-1-11-11-1-1	1-1-1-1-1	1-1-1-1-1	1-1-1-1-1	1-1-1-1-1	1-1-1-1-1	1-1-1-1-1	1-1-1-1-1	1-1-1-1-1	1-1-1-1-1	1-1-1-1-1
COL GRE	---	1132-1-1-1-1-1	22222-1-1-1-1	1111-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1
TAN SWY	12-22221-1222-23	21-223212222212-2	2-22111-121	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1
FIC CHI	---	331-2-231-1-1	212-212121111-1	1-12-1-1-1	1-12-1-1-1	1-12-1-1-1	1-12-1-1-1	1-12-1-1-1	1-12-1-1-1	1-12-1-1-1	1-12-1-1-1	1-12-1-1-1
ARG MAC	---	2-2-1-211112-1-1	22322222222222-2	1-12-1-1-1	1-12-1-1-1	1-12-1-1-1	1-12-1-1-1	1-12-1-1-1	1-12-1-1-1	1-12-1-1-1	1-12-1-1-1	1-12-1-1-1
MYR HOL	222121-24223-1-1	3-1133122211211-1	13332-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1
CRA BRE	1-12-133112131241	13444422144434444	31233-1111-3	1-1-11-1-1	1-1-11-1-1	1-1-11-1-1	1-1-11-1-1	1-1-11-1-1	1-1-11-1-1	1-1-11-1-1	1-1-11-1-1	1-1-11-1-1
DRA FRA	2212212111111111	1-1-1111-1-1-11	1112213-111	1-1111-1211	1-1111-1211	1-1111-1211	1-1111-1211	1-1111-1211	1-1111-1211	1-1111-1211	1-1111-1211	1-1111-1211
PSE SUB	2111-1-121-12221	12-133222321-1	1-1-1-22-1	1-1-1-22-1	1-1-1-22-1	1-1-1-22-1	1-1-1-22-1	1-1-1-22-1	1-1-1-22-1	1-1-1-22-1	1-1-1-22-1	1-1-1-22-1
DID NOR	---	11-1-1-1-1-1-1	---	1-1-1-1-1-1	---	1-1-1-1-1-1	---	1-1-1-1-1-1	---	1-1-1-1-1-1	---	1-1-1-1-1-1
OXY GOE	---	1-1-1-1-1-1-1-11	---	111-1-1-1-1-1	---	111-1-1-1-1-1	---	111-1-1-1-1-1	---	111-1-1-1-1-1	---	111-1-1-1-1-1
DRY GER	---	22221-1-1-1-1-1	---	112-1111-2321-1	---	11222-11-1	---	1-1-1-1-1	---	1-1-1-1-1	---	1-1-1-1-1
TIL FUN	---	22-22-2-2-2-2	---	22222-2-223	---	22-22-112-2	---	2-2-2-22-2	---	2-2-2-22-2	---	2-2-2-22-2
KHA ANT	3-3-3-1-1-1-1-1	---	---	1-1-1-222-2	---	2-2-2-1-1-1	---	1-1-1-1-1	---	1-1-1-1-1	---	1-1-1-1-1
STR MIT	2332-112-1-1-2121	121-111112-22-1	1-212-2-2-1	1-1-212-2-1	1-1-212-2-1	1-1-212-2-1	1-1-212-2-1	1-1-212-2-1	1-1-212-2-1	1-1-212-2-1	1-1-212-2-1	1-1-212-2-1
CHR GOR	1231232211221-21	333333332-32-222	2222212-311	1-11-11-1-1	1-11-11-1-1	1-11-11-1-1	1-11-11-1-1	1-11-11-1-1	1-11-11-1-1	1-11-11-1-1	1-11-11-1-1	1-11-11-1-1
DFO ABY	2212212111111111	1-1-1111-1-1-11	1112213-111	1-1111-1211	1-1111-1211	1-1111-1211	1-1111-1211	1-1111-1211	1-1111-1211	1-1111-1211	1-1111-1211	1-1111-1211
COF LIG	1111-11-1-1-1-1-1	11-1-1-1-1-1-1	1-111221-1	1-111221-1	1-111221-1	1-111221-1	1-111221-1	1-111221-1	1-111221-1	1-111221-1	1-111221-1	1-111221-1
TRI MAD	3-2-12-1-1-1-1-1	1-2-2-211-221-1	---	11-2-2-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1
XYM MON	1-1-31-1-1-1-1-1	211-1-2-2-2-2-2	---	21-1-2-2	---	21-1-2-2	---	1-12-1111-1	---	1-1-1-1-1-1-1	---	1-1-1-1-1-1-1
AGE PEN	2-2-2-22-22-22-2	2-2-2-2-2-2-2-2	---	2-2-2-2-2	---	2-2-2-2-2	---	2-2-2-2-2	---	2-2-2-2-2	---	2-2-2-2-2
PAV COM	1-1-1-1-1-1-1-111	11221-1-1-1-1122	21-1-11-11-11	1-1-1-11-11	1-1-1-11-11	1-1-1-11-11	1-1-1-11-11	1-1-1-11-11	1-1-1-11-11	1-1-1-11-11	1-1-1-11-11	1-1-1-11-11
CRE TRI	11111-11-1-1-1-1	1121-22-111-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1
CEL GOM	1-1-1-1-1-1-1-1-1	---	---	22-221-2-2	---	1-1-1-1-1-1-1	---	1-11-1-1-1	---	1-1-1-1-1-1-1	---	1-1-1-1-1-1-1
RAW LUC	23121121111112211	21111-312-121-1	3-121-1-2231	12111-11-1-111-1111	12111-11-1-111-1111	12111-11-1-111-1111	12111-11-1-111-1111	12111-11-1-111-1111	12111-11-1-111-1111	12111-11-1-111-1111	12111-11-1-111-1111	12111-11-1-111-1111
ROT URC	1333-1221211-2232	1-1-1-1231211-1-1	111111121211	11-11111111111111-1	11-11111111111111-1	11-11111111111111-1	11-11111111111111-1	11-11111111111111-1	11-11111111111111-1	11-11111111111111-1	11-11111111111111-1	11-11111111111111-1
TAB VEN	11222221111221111	2221211121222112	111111121222	1111111121222	1111111121222	1111111121222	1111111121222	1111111121222	1111111121222	1111111121222	1111111121222	1111111121222
BEQ NAT	2-1-1-1-1-1-1-1-1	---	---	1-1-1-1-1-1-1	---	1-1-1-1-1-1-1	---	1-1-1-1-1-1-1	---	1-1-1-1-1-1-1	---	1-1-1-1-1-1-1
CAR BIS	111111-1-1-1-1-1	1111-1211-1-2-2	11-122-11-1	111-11-11-1111-1111-1-1-1	111-11-11-1111-1111-1-1-1	111-11-11-1111-1111-1-1-1	111-11-11-1111-1111-1-1-1	111-11-11-1111-1111-1-1-1	111-11-11-1111-1111-1-1-1	111-11-11-1111-1111-1-1-1	111-11-11-1111-1111-1-1-1	111-11-11-1111-1111-1-1-1
CNE POL	---	1-11-1-1-1-1-1	---	111-1-1-1-1-1	---	111-1-1-1-1-1	---	1-111-1-1-1	---	1-111-1-1-1	---	1-111-1-1-1
LOV SWY	1-1-1-1-1-1-1-1-1	1-1-1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1	1-1-1-1-1-1-1
NEW BUC	2333-2-1-1-1-1-1	---	---	2-11122121-2	---	12-22-11-1	---	1-1-1-1-1	---	1-1-1-1-1	---	1-1-1-1-1
OCH ARB	---	---	---	22112-1	---	---	---	1-1-1-1-1	---	1-1-1-1-1	---	1-1-1-1-1
DOV MAC	1-11-1-1-1-111-1	11-231-1-1	11-2212-1	2-1-2-1-1-1-1	1-1-1-11-1111-1111-1-1-1	1-1-1-11-1111-1111-1-1-1	1-1-1-11-1111-1111-1-1-1	1-1-1-11-1111-1111-1-1-1	1-1-1-11-1111-1111-1-1-1	1-1-1-11-1111-1111-1-1-1	1-1-1-11-1111-1111-1-1-1	1-1-1-11-1111-1111-1-1-1
TAR PAV	---	1-11-1-1-1-1-1	---	111-112-1	---	111111-1	---	2-11111-12-111121	---	1-1-1-1-1	---	1-1-1-1-1
TRI DRE	---	122-2-2-1-1-1	---	3-1-22-12-1-1	---	22-21-1-1	---	1-111-11-11-1111-1111-12-1-1	---	1-1-1-1-1	---	1-1-1-1-1
XYL PAR	---	11-1-1-1-1-1-1-1	---	11111-2-2	---	131-1-1-1-1	---	1-1-1-1-1	---	1-1-1-1-1	---	1-1-1-1-1
DRA FAN	---	---	---	---	---	---	---	---	---	---	---	---
CEL SWY	---	22-2-2-22-2	---	2-2-2	---	2232-2	---	2-2-2-2-2	---	2-2-2-2-2	---	2-2-2-2-2
TEC NOR	211-2-1-1-1-1111	1112-31-1-1-1-1	22122342-1	1-2-123221-11	---	1112-1-1	---	111-122212	---	111-122212	---	111-122212
EHR CYM	---	---	---	21131111-1	---	222-1	---	2-2-2-1-1	---	2-2-2-3-1	---	2-2-2-3-1
CEL AFR	---	---	---	22-321-2-1	---	11-112411-1	---	2-2-2-1-111	---	222112-1	---	222112-1
OAS BAT	---	2-1-1-1-1-1-1-1	---	1-1-221	---	21-1-1-1121123222-121111-1-1-1	---	1-1-1-1-1-1-1	---	1-1-1-1-1-1-1	---	1-1-1-1-1-1-1
PED AFR	---	1-1-11-1-1-1-1-1	---	11-112-112	---	2-12-111211123222-121111-1-1-1	---	1211-13222-1	---	111111-1	---	111111-1
POF FUL	---	2-2-2-2-1-2-2-2	---	21-213-211-211-2	---	111222-2-1	---	221111233-1111-12111-11111111-1111	---	13222-1	---	1-1-1-1-1
ALB GUM	---	1-1-1-1-1-1-1-1	---	12-1-1-1-1-1	---	1-1-1-1-1-1-1-1	---	1-11121-1-1-1-1-1	---	1-1-1-1-1	---	1-1-1-1-1
CAS MAL	---	11-1-11-122-1	---	1-1-1-2	---	11-112211112	---	221133212221212322121212121222111	---	11222112	---	1-2111-1-1
HAL LUC	---	1-1-1-1-1-1	---	11-2-1-1	---	1-1-1111-111	---	1-1-1111-111	---	1-1-1111-111	---	1-1-1111-111
SCO STO	---	---	---	2-2-1-1-1	---	2-2-1-1-1	---	2-2-1-1-1	---	2-2-1-1-1	---	2-2-1-1-1
AU CAF	---	3-1-1-1-1	---	1-2-2-1	---	12-2-2-1-1	---	1-11223-1-1-1-1	---	1-1-1-1-1	---	1-1-1-1-1
BRE SWY	---	1-1-1-1-1-1-1-1	---	1-1-1-1-1	---	1-1-1-1-1-1-1-1	---	1-1-1-1-1-1-1-1	---	1-1-1-1-1	---	1-1-1-1-1
OXY SPE	---	---	---	1-1-1-1-1-1-1-1	---	1-111-1-1-1-11111-1	---	1-1-1-1-1-1-1-1	---	1-1-1-1-1	---	1-1-1-1-1
CAL AUR	1-1-1-1-1-1-1-1-1	---	---	11-1-1-1	---	132-1	---	1-1-1-1-1-1-1-1	---	2121-1	---	2121-1
MEL LOB	---	2-1-1-1-1-1-1-1	---	2-1-1-1-1	---	3-11-1	---	2-3-1-				

[illegible]

This forest consists of a lower upper canopy of various species with occasional emergents. The average height is generally lower (about 30–40 m) than the other forest types (which are about 50–60 m in most areas) except for

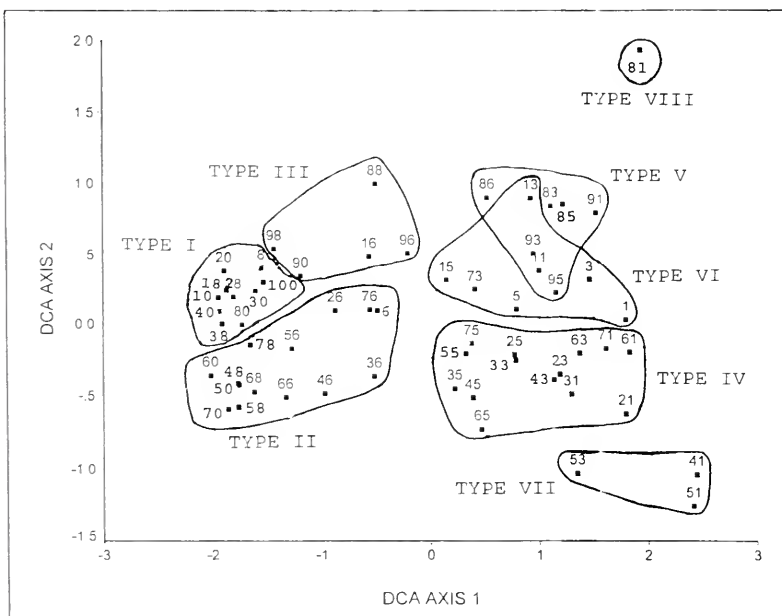


FIGURE 4.—A DCA ordination diagram showing the grouping of stands.

the emergents. It is dominated by *Strychnos mellodora*, *Chrysophyllum gorungosanum*, *Craibia brevicaudata* and *Tannodia swynnertonii*. Emergent species include *Strychnos mitis*, *S. usambarensis* and strangler *Ficus* spp., in particular *F. chirindensis*. The lower layer (which is not markedly different from the upper canopy) is dominated by *Strychnos mellodora*, *Rawsonia lucida*, *Heinsenia diervilleoides* and *Tabernaemontana ventricosa*. This forest type is found mainly in the area surrounding the sandstone enclave. Common shrubs include the young of the canopy species and low densities of *Dracaena fragrans*. *Acacia pentagona* and *Landolphia buchananii* are the most common lianes.

Chrysophyllum gorungosanum–*Myrianthus holstii* Forest (Type II)

This forest is dominated by *Chrysophyllum gorungosanum*, *Myrianthus holstii*, *Strombosia scheffleri* and *Craibia brevicaudata* in the upper canopy stratum. The area covered by this type coincides with the wetter parts of the forest. *Khaya anthotheca* is quite common in some places. *Dracaena fragrans* is the dominant shrub and apparently locally excludes other shrubs due to its high densities. *Strychnos mellodora* is largely absent from the subcanopy, which is instead dominated by *Heinsenia diervilleoides*, *Rothmannia urcelliformis*, *Tannodia swynnertonii* and *Tabernaemontana ventricosa*. *Cola greenwayi* and *Drypetes gerrardii* are also fairly common. The most common lianes are *Acacia pentagona*, *Hippocratea goetzei*, *H. pallens* and *Oncinotis tenuiloba*.

Teclea nobilis–*Ehretia cymosa* Forest (Type III)

This forest consists of a mixture of species of apparently drier forest affinities. It is dominated by *Teclea nobilis* and *Ehretia cymosa*. Common associates include *Chrysophyllum gorungosanum*, *Diospyros abyssinica* and *Ochna arborea*. It is found in the northwestern part of the forest adjacent to an area which seems to have been cultivated during the 1940s. *Celtis africana*, *Newtonia buchananii* and *Peddiea africana* form the dominant group in the shrublayer. There is high prevalence of small trees of pioneer species such as *Newtonia buchananii* and *Croton sylvaticus*.

Bridelia micrantha–*Harungana madagascariensis* Mixed Woodland (Type IV)

This woodland, which appears to be more of a secondary nature, is more developed in the area just south of the Mount Selinda Mission on a north-facing slope, where it forms a belt extending towards the southeastern part of the forest boundary. It is characterized by large, but widely spaced, *Bridelia micrantha* trees with occasional *Macaranga capensis* and *Cussonia spicata*. The lower stratum is dominated by *Harungana madagascariensis*. Thickets of *Toddalia asiatica*, *Asparagus falcatus* and, sometimes, *Smilax anceps* are a common feature of the shrub layer. *Harungana madagascariensis*, however, ceases to be dominant in some localities where *Pterocarpus rotundifolius* trees and *Albizia gummifera* saplings form an important component of the woodland. *Peddiea africana* shrubs and *Croton sylvaticus* seedlings are also common.

Acacia karroo–*Heteropyxis dehniae* Woodland (Type V)

This woodland, which is dominated by *Acacia karroo*, *Heteropyxis dehniae* and *Faurea saligna*, is on the drier side of the forest and just merges into the miombo woodland (dominated by *Julbernardia globiflora*, *Uapaca kirkiana*, *U. sansibarica* and *Brachystegia spiciformis*). It is mostly found between the moist forest proper and well-defined non-forest associations. It contains a wide variety of species including pioneer species such as *Bridelia micrantha*, *Albizia gummifera*, *Croton sylvaticus* and *Newtonia buchananii*. A form of this vegetation type also occurs in small patches elsewhere around the forest, with varying degrees of dominance among the component species. Occasional emergents include *Parinari curatellifolia*, *Catha edulis* and *Prunus africana*. Shrubs are represented by *Psidium guajava*, *Vangueria apiculata*, *Rhus longipes* and *R. transvaalensis*.

Psidium guajava Bushland (Type VI)

This bushland is dominated by the exotic *Psidium guajava* and by *Canthium mundianum* bushes and sometimes assumes the structure of a low woodland. It is found in the sandstone enclave. A few emergent trees of *Parinari curatellifolia* and *Albizia gummifera* occur. Thickets of *Toddalia asiatica*, *Lantana camara* and *Rubus rigidus* are common, particularly near the boundary with the moist forest. *Peddiea africana* and *Pteridium aquilinum* are also common.

Themeda triandra Grassland (Type VII)

This bushed grassland vegetation is dominated by *Themeda triandra* and *Cymbopogon caesius*. It occurs on shallow dolerite soils with occasional exposed boulders. There is local variation in grass species dominance, with *Loudetia simplex* apparently becoming more dominant on east-facing slopes of the southern part of the forest where the soils are deeper and mostly sandy, sometimes with *Parinari curatellifolia* bushes. Other woody species found within the *Themeda* grassland include *Psidium guajava*, *Eriosema nutans*, *Pseudarthria hookeri* and *Athrixia rosmarinifolia*.

Julbernardia globiflora–*Brachystegia spiciformis* Woodland (Type VIII)

An additional woodland type to those apparent in the TWINSpan classification was identified by DCA, a miombo woodland dominated by *Julbernardia globiflora* and *Brachystegia spiciformis* with *Uapaca kirkiana*, *Heteropyxis dehniae* and *Faurea saligna* as common associates in the canopy layer. It is relatively open, with poorly developed shrub and herb layers. Common trees in the subcanopy layer include *Heteropyxis dehniae*, *Faurea saligna*, *Canthium mundianum*, *Julbernardia globiflora* and *Brachystegia spiciformis*. Grasses include *Digitaria gazensis* and *Themeda triandra*. The TWINSpan analysis lumps this type with *Acacia karroo*–*Heteropyxis dehniae* Woodland (Type V) but DCA clearly separates it from the rest.

Ordination

The first DCA axis, which accounted for 63% of the observed variation, separated the forest and adjacent non-forest vegetation types, with a wide gap of up to one DCA unit between them (Figure 4). In general, stands close to the forest edge, from either side, were closer to the centre of Axis 1 than stands further from the forest edge. Nevertheless, the stands lying adjacent to one another along the forest edge were quite separate with 0.5–2 DCA units between them. Three groups of forest stands were distinguishable, corresponding to those identified in the classification by TWINSpan. These groups are not separated along the first DCA axis but are distinguishable along the second DCA axis, which accounted for 19.6% of the variation. A similar pattern is also apparent in the ordination of the woodland groups of stands.

Miombo woodland is clearly separated from other woodland stands along the second DCA axis. The grassland stands are, likewise, clearly separated from the woodland stands. There is considerable overlap between the stands from the sandstone enclave and those from the northwestern part of the forest (i.e. the *Psidium guajava* Bushland (Type VI) and *Acacia karroo*–*Heteropyxis dehniae* Woodland (Type V).

The existence of the *Chrysophyllum gorungosanum*–*Myrianthus holstii* Forest (Type II) on the southeastern to the southwestern sides adjacent to the grassland was associated with a higher altitude and a wetter moisture regime, regardless of the shallow soils. *Psidium guajava* Bushland (Type VI) occurred where the soils were predominantly sandstone and relatively deep. Where the sandstone soils were steeper and shallower, miombo and sometimes *Acacia karroo*–*Heteropyxis dehniae* Woodland (Type V) occurred. On dolerite, with the same conditions, *Strychnos mello-dora*–*Chrysophyllum gorungosanum* Forest (Type I) occurred, whereas the *Teclea nobilis*–*Ehretia cymosa* Forest (Type III) occurred where it was drier. The *Bridelia micrantha*–*Harungana madagascariensis* Mixed Woodland (Type IV) occurred on predominantly dolerite soils with other factors being intermediate. This was also found in what appeared to be geological transitional zones.

DISCUSSION

Vegetation types

The vegetation of Chirinda Forest boundary has been classified into eight types. This represents only those types occurring within 100 m on either side of the forest edge.

The TWINSpan analysis clearly separated forest from non-forest stands. The stands close to the forest edge, however, were not clearly separated on the basis of whether they were just inside or just outside the forest, as might have been expected. The apparent lack of clear differentiation may be due to the existence of some species that are transitional between forest and woodland. Such a vegetation unit, which normally consists of both fire-tolerant savanna and fire-tender forest tree species (Hopkins 1992), represents a mosaic of communities of each of the two vegetation types. The transitional vegeta-

tion between savanna and forest shows great variation in both structure and species composition from place to place around the forest. Some of the types described in this category are restricted in extent whereas others occur widely, though in patches.

The transitional vegetation includes forest pioneer species. Most pioneer species in Chirinda Forest are Afromontane endemics or near-endemics which are absent or rare in lowland forests. These include *Albizia gummifera*, *Anthocleista grandiflora* and *Maesa lanceolata*. Hence, the forest has sometimes been labelled a 'transitional' forest because of the co-existence of both lowland and Afromontane forest species (White 1978). Even though the majority of the moist forest species have lowland phyto-geographic affinities, several species such as *Chrysophyllum gorungosanum* (which is one of the commonest), *Casearia battiscombei*, *Drypetes gerrardii*, *Halleria lucida*, *Myrianthus holstii*, *Prunus africana*, *Strombosia scheffleri* and *Xymalos monospora* are Afromontane in origin. Chirinda Forest is, therefore, Afromontane in origin and character but with lowland phyto-geographic affinities.

The southern section of the forest supports *Chrysophyllum gorungosanum*–*Myrianthus holstii* Forest (Type II), with more *Khaya anthotheca* and *Trichilia dregeana*, whereas the northern section mainly supports the *Strychnos mello-dora*–*Chrysophyllum gorungosanum* Forest (Type I) with more *Craibia brevicaudata* and *Strychnos mitis*. Perhaps the greatest difference between these forest types manifests itself in the variation in species composition of the understorey. This difference seems to be determined by soil depth and slope, which also influence the moisture regime. Shallow and steep sites drain faster than areas of moderate slope, leading to differences in the undergrowth species composition. Understorey species are therefore important in defining the limits of these two types.

The forest and woodland vegetation types share only a few species between them. Greater overlap in species composition was observed between the forest and the ecotonal vegetation than between forest and, for instance, miombo woodland. Shared species appear to occur mostly as seedlings, and less so as trees, in those habitat types to which they do not characteristically belong. Some of these, such as *Croton sylvaticus*, *Harungana madagascariensis* and *Bridelia micrantha* are, however, true pioneers which thrive well under gap conditions in forests.

Ordination

Forest generally occurs in wetter environments, and savanna in drier ones (Backeus 1992). In Chirinda, the amount of precipitation received from rainfall in the area is lower than the normal requirement for forest development. The extra moisture comes in the form of orographic drizzle, made possible by several factors: the high ground, the southeasterly aspect, and the tall trees which facilitate the release of this extra moisture from the low clouds. The southern section of the forest has shallower soils, but a higher average altitude and receives more moisture from the south-easterlies, advected in from the Mozambique Channel, than the northern section. In general, Chirinda receives up to 28% more moisture than the average of

five surrounding stations, much of which can be attributed to orographic drizzle (Mapaure 1993).

Miombo Woodland (Type VIII) was clearly classified separately from the *Acacia karroo*–*Heteropyxis dehniae* Woodland (Type V) by DCA but not by TWINSpan. This might have been due to the apparent importance attached to *Heteropyxis dehniae* by TWINSpan in Types V and VIII, resulting in the recognition of these types as one. Also of much interest, is the distance of separation between the dominant forest type [*Chrysophyllum gorungosanum*–*Myrianthus holstii* Forest (Type II)] and the rest of the non-forest types on the DCA ordination diagram. The DCA distance between the stands represents the average standard deviation of the species turnover, where a full species turnover occurs in about four DCA units (Gauch 1982). Thus, the DCA units between the types in Chirinda Forest represent about a 50% change in sample species composition, indicating a more or less abrupt change. This change may indicate the strength of geology in determining the extent of the forest, since all forest stands occurred on dolerite.

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APPENDIX 1.—Full names of plants appearing in Table 1. Synonyms in square brackets.

MNEMONIC	FULL NAME AND AUTHORITY	CEL MIL	Celtis mildbraedii Engl.
ACA KAR	<i>Acacia karroo</i> Hayne	CHI BAT	<i>Chionanthus battiscombei</i> (Hutch.) Stearn
ACA SIE	<i>Acacia sieberiana</i> DC.	CHR GOR	<i>Chrysophyllum gorungosanum</i> Engl.
AGE PEN	<i>Agelaea pentaphylla</i> (Lam.) Baill.	CLA ANI	<i>Clausena anisata</i> (Willd.) Hook.f. ex Benth.
ALB GUM	<i>Albizia gummifera</i> (J.F.Gmel.) C.A.Sm.	CLE SWY	<i>Clerodendrum swynnertonii</i> S.Moore
ANN SEN	<i>Annona senegalensis</i> Pers.	CLU SWY	<i>Clusia swynnertonii</i> S.Moore
ANT VEN	<i>Antidesma venosum</i> Tul.	CNE POL	<i>Cnestis polyphylla</i> Lam.
ARG MAC	<i>Argemoullera macrophylla</i> Pax	COF LIG	<i>Coffea ligustroides</i> S.Moore
ARG TOM	<i>Argyrobolium tomentosum</i> (Andrews) Druce	COL GRE	<i>Cola greenwayi</i> Brenan
ASP PLU	<i>Aspilia pluriseta</i> Schweinf. subsp. pluriseta	COM MOL	<i>Combretum molle</i> R.Br.
ATH ROS	<i>Athrixia rosmarinifolia</i> (Walp.) Oliv. & Hiern	CRA BRE	<i>Craibia brevicaudata</i> (Vatke) Duum subsp. baptistarum (Büttner) J.B.Gillet
BEQ NAT	[<i>Bequaertiodendron natalense</i> (Sond.) Heine & J.H.Hemsl.] <i>Englerophytum natalense</i> (Sond.) Pennington	CRE TRI	<i>Cremaspora triflora</i> (Thonn.) K.Schum.
BER ABY	<i>Bersama abyssinica</i> Fresen.	CRO SYL	<i>Croton sylvaticus</i> Hochst.
BRA SPI	<i>Brachystegia spiciformis</i> Benth.	CRY LIE	<i>Cryptocarya liebertaina</i> Engl.
BRI MIC	<i>Bridelia micrantha</i> (Hochst.) Baill.	CUS SPI	<i>Cussonia spicata</i> Thunb.
CAL AUR	<i>Calpurnia aurea</i> (Aiton) Benth. subsp. aurea	CYM CAE	<i>Cymbopogon caesius</i> (Hook. & Arn.) Stapf
CAN MUN	<i>Canthium mundianum</i> Cham. & Schltdl.	DES SET	<i>Desmodium setigerum</i> (E.Mey.) Harv.
CAR BIS	<i>Carissa bispinosa</i> (L.) Desf. ex Brenan subsp. bispinosa	DIC CIN	<i>Dichrostachys cinerea</i> (L.) Wight & Arn.
CAS BAT	<i>Casearia battiscombei</i> R.E.Fr.	DID NOR	<i>Didymosalpinx norae</i> Swynn.
CAS MAL	<i>Cassipourea malosana</i> (Baker) Alston	DIO ABY	<i>Diospyros abyssinica</i> (Hiern) F.White
CAT EDU	<i>Catha edulis</i> (Vahl) Endl.	DIO LYC	<i>Diospyros lycioides</i> Desf.
CEL AFR	<i>Celtis africana</i> Burn.f.	DOM BUR	<i>Dombeya burgessiae</i> Harv.
CEL GOM	<i>Celtis gomphophylla</i> Baker	DOV MAC	<i>Dovyalis macrocalyx</i> (Oliv.) Warb.

DRA FRA	<i>Dracaena fragrans Ker Gawl.</i>	PRU AFR	<i>Prunus africana (Hook.f.) Kalkman</i>
DRA MAN	<i>Dracaena mannii Baker</i>	PSE HOO	<i>Pseudarthria hookeri Wight & Arn.</i>
DRY GER	<i>Drypetes gertardii Hutch.</i>	PSE SUB	<i>Pseuderanthemum subviscosum (C.B.Clarke) Stapf</i>
EHR CYM	<i>Ehretia cymosa Thonn. var. divaricata (Baker) Brenan</i>	PSI GUA	<i>Psidium guajava L.</i>
ERI NUT	<i>Eriosema nutans Schinz</i>	PSO FEB	<i>Psorospermum febrifugum Spach</i>
ERY LYS	<i>Erythrina lysistemon Hutch.</i>	PTE ROT	<i>Pterocarpus rotundifolius (Sond.) Druce</i>
EUC DIV	<i>Euclea divinorum Hiern</i>	RAU CAF	<i>Rauvolfia caffra Sond.</i>
FAD CIE	<i>Fadogia cienkowski Schwinf.</i>	RAW LUC	<i>Rawsonia lucida Harv. & Sond.</i>
FAU SAL	<i>Faurea saligna Harv.</i>	RHA PRI	<i>Rhamnus prinoides L'Hér.</i>
FIC CHI	<i>Ficus chirindensis C.C.Berg</i>	RHO REV	<i>Rhoicissus revoliï Planch.</i>
FIC SUR	<i>Ficus sur Forssk.</i>	RHU LON	<i>Rhus longipes Engl.</i>
FLE GRA	<i>Flemingia grahamiana Wight & Arn.</i>	RHU TEN	<i>Rhus tenuinervis Engl.</i>
GRE OCC	<i>Grewia occidentalis L. var. occidentalis</i>	RHU TRA	<i>Rhus transvaalensis Engl.</i>
HAL LUC	<i>Halleria lucida L.</i>	RHY SWY	<i>Rhynchosia swynnertonii Baker f.</i>
HAR MAD	<i>Harungana madagascariensis Poir.</i>	RIN FER	<i>Rinorea ferruginea (Baker f.) M.Brandt</i>
HEI DIE	<i>Heinsenia diervilleoides K.Schum.</i>	ROT URC	<i>Rothmannia urcelliformis (Hiern) Bullock</i>
HET DEH	<i>Heteropyxis dehniae Stuess.</i>	RUB RIG	<i>Rubus rigidus J.E.Sm.</i>
HET TRI	<i>Heteromorpha trifoliata (H.L.Wendl.) Eckl. & Zeyh.</i>	RUB COR	<i>Rubia cordifolia L. subsp. conotricha (Gand.) Verdc.</i>
HYP ARI	<i>Hypoestes aristata (Vahl) Roem. & Schult.</i>	RUT FUS	<i>Rutidea fuscescens Hiern</i>
IND HED	<i>Indigofera bedyantha Eckl. & Zeyh.</i>	SAP ELL	<i>Sapium ellipticum (Hochst.) Pax</i>
IND SWA	<i>Indigofera swaziensis Bolus</i>	SCO STO	<i>Scolopia stolzii Gilg</i>
JUL GLO	<i>Julbernardia globiflora (Benth.) Troupin</i>	SEN LAT	<i>Senecio latifolius DC.</i>
KEE GUE	<i>Keetia gueinzii (Sond.) Bridson</i>	SEN SEP	<i>Senna septemtrionalis (Viv.) Irwin & Barneby</i>
KHA ANT	<i>Khaya anthotheca Baker f.</i>	SEN SIN	<i>Senna singueana (Delile) Lock</i>
LAN CAM	<i>Lantana camara L.</i>	SPH PRU	<i>Sphegamnocarpus pruriens (A.Juss.) Szyzyl.</i>
LIP JAV	<i>Lippia javanica (Burn.f.) Spreng.</i>	STR MEL	<i>Strychnos mellodora S.Moore</i>
LOV SWY	<i>Lovoa swynnertonii Baker f.</i>	STR MIT	<i>Strychnos mitis S.Moore</i>
MAC CAP	<i>Macaranga capensis (Baill.) Sim</i>	STR SPI	<i>Strychnos spinosa Lam.</i>
MAE LAN	<i>Maesa lanceolata Forssk.</i>	STR USA	<i>Strychnos usambarensis Gilg</i>
MAY HET	<i>Maytenus heterophylla (Eckl. & Zeyh.) N.Robson</i>	STR SCH	<i>Strombosia scheffleri Engl.</i>
MAY SEN	<i>Maytenus senegalensis (Lam.) Exell</i>	SYZ GUG	<i>Syzygium guineense (Willd.) DC. subsp. guineense</i>
MEL LOB	<i>Mellera lobulata S.Moore</i>	TAB VEN	<i>Tabernaemontana ventricosa Hochst. ex A.DC.</i>
MYR HOM	<i>Myrianthus holstii Engl.</i>	TAN SWY	<i>Tannodia swynnertonii (S.Moore) Prain</i>
NEW BUC	<i>Newtonia buchananii (Baker) G.C.C.Gilbert & Boutique</i>	TAR PAV	<i>Tarenna pavettoides (Harv.) Sim subsp. affinis (K.Schum.) Bridson</i>
OCH ARB	<i>Ochna arborea DC. var. oconnorii (E.Phillips) Du Toit</i>	TEC NOB	<i>Teclea nobilis Delile</i>
OCI GRA	<i>Ocimum gratissimum L. var. gratissimum</i>	TEP LON	<i>Tephrosia longipes Meisn. subsp. swynnertonii (Baker f.) Brummitt</i>
OXY GOE	<i>Oxyanthus goetzei K.Schum. subsp. goetzei</i>	THE TRI	<i>Themeda triandra Forssk.</i>
OXY SPE	<i>Oxyanthus speciosus DC.</i>	TIL FUN	<i>Tiliacora funifera (Miers) Oliv.</i>
PAR CUR	<i>Parinari curatellifolia Planch. ex Benth.</i>	TRE ORI	<i>Trema orientalis (L.) Blume</i>
PAV COM	<i>Pavetta comostyla S.Moore subsp. comostyla var. comostyla</i>	TRI DRE	<i>Trichilia dregeana Sond.</i>
PED AFR	<i>Peddiea africana Harv.</i>	TRI PIN	<i>Triumfctia pilosa Roth var. nyasana Sprague & Hutch.</i>
PHY NUM	<i>Phyllanthus nummulariifolius Poir.</i>	TRI MAD	<i>Trilepisium madagascariense DC.</i>
PLE PYC	<i>Pleiocarpa pycnantha (K.Schum.) Stapf</i>	VAN API	<i>Vangueria apiculata K.Schum.</i>
POL FUL	<i>Polyscias fulva (Hiern) Harms</i>	VAN INF	<i>Vangueria infausta Burch.</i>
PRO FAL	<i>[Protasparagus falcatus (L.) Oberm.] Asparagus falcatus L.</i>	VER COL	<i>Vernonia colorata (Willd.) Drake</i>
PRO LAR	<i>[Protasparagus laricinus (Burch.) Oberm.] Asparagus laricinus Burch.</i>	XYL PAR	<i>Xylopia parviflora (A.Rich.) Benth.</i>
PRO PLU	<i>[Protasparagus plumosus (Baker) Oberm.] Asparagus plumosus Baker</i>	XYM MON	<i>Xymalos monospora (Harv.) Baill.</i>

Red Data List of southern African plants. 2. Corrections and additions

C. HILTON-TAYLOR*

Keywords: IUCN Red List categories, Red Data List, southern Africa

INTRODUCTION

This update to the *Red Data List of southern African plants* (Hilton-Taylor 1996a) follows the same format as that used in the first update (Hilton-Taylor 1996b). However, a major change in the methodology used is the application of the new IUCN Red List categories and criteria (IUCN 1994). Wherever possible, all taxa added to the Red Data List and all those which have a change in status, have been evaluated using the new system in addition to assigning an old IUCN Red List category. The dual system of old and new IUCN categories will be maintained, until all taxa listed as threatened have been evaluated under the new system.

The new IUCN categories and criteria were developed to improve the objectivity in assessing the conservation status of species, thereby improving consistency between users. Although the new categories were developed after six years of research and broad consultation, numerous problems with implementation and interpretation have emerged since their adoption by the IUCN Council in 1994. At the IUCN World Conservation Congress held in Montréal in October 1996, the IUCN's Species Survival Commission (SSC) was requested to conduct a review of the new categories and criteria, especially their effectiveness and applicability to a wide range of organisms, habitats and threatening processes. Despite the problems encountered, the new criteria and categories were effectively applied to produce the 1996 *IUCN Red List of threatened animals* (Baillie & Groombridge 1996). Botanists are now being encouraged to apply the new system to plants in order to identify what problems they might encounter with the new system. As a major contributor to the forthcoming 1997 *IUCN Red List of threatened plants* (Walter & Gillett in press), the National Botanical Institute should lead the way in southern Africa.

The new categories and criteria will be briefly described here, so that the methodology, abbreviations and terminology used in the update below can be understood. This description must be used in conjunction with the official *IUCN Red List categories* document (IUCN 1994). The description also draws extensively on the summary published in Baillie & Groombridge (1996), on various guidelines prepared for workshops on the application of the new system (Baillie 1995, 1996; Jenkins 1996) and the discussions held during those workshops.

At the outset, it is essential to note that the new IUCN categories and criteria are meant to be applied on a global scale to determine the current global conservation status of a taxon. They are not intended for use at a local, national or regional level, unless the taxon concerned is endemic to the area defined. The IUCN is currently developing a parallel system which can be applied at different biogeographic and geopolitical scales. This proviso is strictly adhered to in the assessments presented below.

NEW IUCN RED LIST CATEGORIES

There are eleven well-defined categories and subcategories in the new system. The definitions presented here are from the official document (IUCN 1994):

Extinct (EX)

A taxon is Extinct when there is no reasonable doubt that the last individual has died.

Extinct in the Wild (EW)

A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times, throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

Critically Endangered (CR)

A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future, as defined by any of the criteria A to E (see Table 1).

Endangered (EN)

A taxon is Endangered when it is not Critically Endangered but is facing high risk of extinction in the wild in the near future, as defined by any of the criteria A to E (see Table 1).

Vulnerable (VU)

A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future, as defined by any of the criteria A to E (see Table 1).

Lower Risk (LR)

A taxon is Lower Risk when it has been evaluated and does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable. Taxa included in the Lower Risk category can be separated into three subcategories:

* Ecology and Conservation, National Botanical Institute, Private Bag X7, Claremont, 7735 Cape Town.
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1. **Conservation Dependent (cd).** Taxa which are the focus of a continuing taxon-specific or habitat-specific conservation programme targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years.

2. **Near Threatened (nt).** Taxa which do not qualify for Conservation Dependent, but which are close to qualifying for Vulnerable.

3. **Least Concern (lc).** Taxa which do not qualify for Conservation Dependent or Near Threatened.

Data Deficient (DD)

A taxon is Data Deficient when there is inadequate information to make a direct or indirect assessment of its risk of extinction based on distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution is lacking. Data Deficient is therefore

not a category of threat or Lower Risk. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and threatened status. If the range of a taxon is suspected to be relatively circumscribed, if a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

Not Evaluated (NE)

A taxon is Not Evaluated when it has not yet been assessed against the criteria.

It is important to note that these new categories are very different to those in the old system (Hilton-Taylor 1996a), so one cannot simply transfer a taxon from an

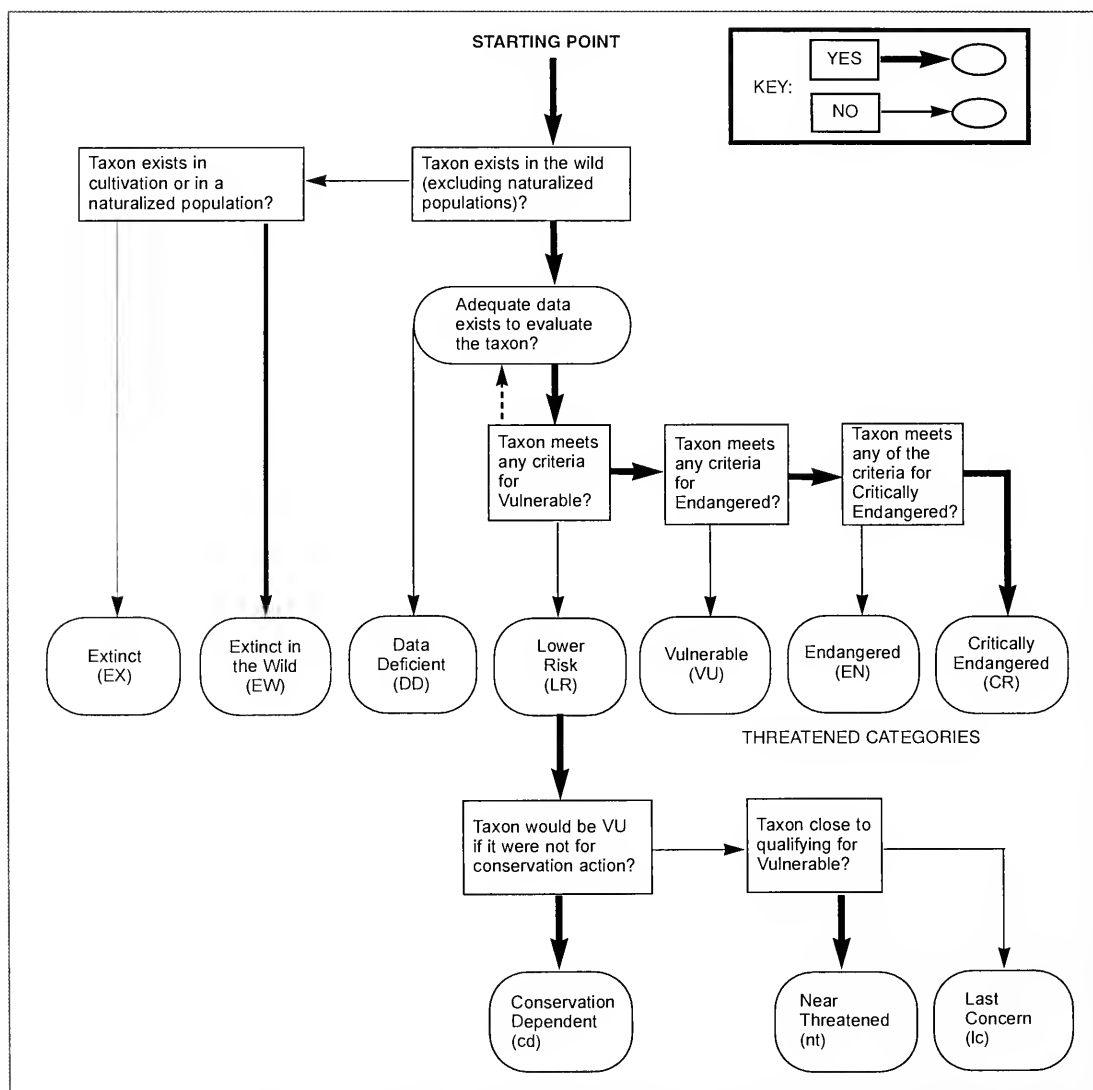


FIGURE 1.—Diagram (from Baillie 1995) to evaluate the current status of a specific taxon. If a taxon is not classified according to this process then it should be listed as Not Evaluated (NE).

old category to a new one without proceeding through the evaluation process (see Figure 1). The only category in the old system which may be regarded as analogous to one in the new system is Insufficiently Known (K). Provided no new information is available, taxa with this status can be transferred to Data Deficient (DD).

Figure 1 illustrates the process that may be followed in evaluating the status of a taxon, and Table 1 is a summary of the five criteria and many subcriteria which are used in assigning threatened status. To list a taxon in any of the categories of threat (Critically Endangered, Endangered and Vulnerable), only one of the five criteria (A to E) and required number of subcriteria need to be met. A taxon should, however, be ascribed as many cri-

teria as are applicable for a specific category of threat. In assigning a status, all the criteria met should be specified. For example, if a taxon is evaluated to be Critically Endangered, its status could be recorded as follows: CR A2cd, B1+2de, C2a. Naturally many of the criteria for the lower categories of Endangered and Vulnerable would also be met in this case; these should not be specified. This listing of the criteria and subcriteria used, provides the reasoning for placing a taxon in a specific category, and if questioned, the reasoning can be re-examined.

Before starting the evaluation of any taxon it is important that the definitions of the following terms, as used in the criteria, must be clearly understood: population, sub-

TABLE 1.—Summary of New IUCN Categories and Criteria (from Baillie & Groombridge 1996)

Use any of the A to E criteria	Critically Endangered	Endangered	Vulnerable
A. Declining Population population decline rate at least using either 1. population reduction observed, estimated, inferred, or suspected in the past <i>or</i> 2. population decline projected or suspected in the future based on: a. direct observation b. an index of abundance appropriate for the taxon c. a decline in area of occupancy, extent of occurrence and/or quality of habitat d. actual or potential levels of exploitation e. the effects of introduced taxa, hybridization, pathogens, pollutants, competitors, or parasites	80% in 10 years or 3 generations	50% in 10 years or 3 generations	20% in 10 years or 3 generations
B. Small Distribution and Decline or Fluctuation Either extent or occurrence or area of occupancy and 2 of the following 3: 1. either severely fragmented: (isolated subpopulations with a reduced probability of recolonization, if once extinct) or known to exist at a number of locations 2. continuing decline in any of the following: a. extent of occurrence b. area of occupancy c. area, extent and/or quality of habitat d. number of locations or subpopulations e. number of mature individuals 3. fluctuating in any of the following a. extent of occurrence b. area of occupancy c. number of locations or subpopulations d. number of mature individuals	< 100 km ² < 10 km ² = 1 any rate > 1 order/mag.	< 5 000 km ² < 500 km ² ≤ 5 any rate > 1 order/mag.	< 20 000 km ² < 2 000 km ² ≤ 10 any rate > 1 order/mag.
C. Small Population Size and Decline Number of mature individuals and 1 of the following 2: 1. rapid decline rate 2. continuing decline and either: a. fragmented or b. all individuals in a single subpopulation	< 250 25% in 3 years or 1 generation any rate all sub-pops ≤ 50	< 2 500 20% in 5 years or 2 generations any rate all sub-pops ≤ 250	< 10 000 10% in 10 years or 3 generations any rate all sub-pops ≤ 1 000
D. Very Small or Restricted Either 1, number of mature individuals or 2, population is susceptible	< 50 (not applicable)	< 250 (not applicable)	< 1 000 area of occupancy < 100 km ² or number of locations < 5
E. Quantitative Analysis Indicating the probability of extinction in the wild to be at least	50% in 10 years or 3 generations	20% in 20 years or 5 generations	10% in 100 years

population, mature individuals, generation, continuing decline, reduction, extreme fluctuation, severely fragmented, extent of occurrence, area of occupancy, location and quantitative analysis. Space does not permit an explanation here of all the terms used, so readers are referred to the official document (IUCN 1994). It is important though to note the difference between the terms population and subpopulation. The population is defined as the total number of individuals of the taxon (i.e. the global population) whereas subpopulations are geographically or otherwise distinct groups in the population between which there is little genetic exchange. In all cases the number of individuals refers to mature individuals, i.e. only those which are capable of reproduction.

As the new IUCN Red List categories have been applied by biologists working on widely different taxonomic groups, differences in interpretation and/or application of the new categories and criteria have emerged. It is important to document these deviations from the standards so that it is clear what is meant. For the assessments presented below there are two slight deviations:

1) Taxa which are known only from an old type collection or only from a couple of old collections, have in the past usually been allocated the status of Insufficiently Known (K) or Indeterminate (I). If the most recent collection was made more than fifty years ago and the taxon was recorded from an area which is well collected and frequently visited by botanists, then the taxon is classified as Extinct (EX) or Extinct in the Wild (EW) if there are plants in cultivation. In most cases there have been some attempts to relocate the taxon, but possibly not with the exact rigor described under the definition of Extinct. The possibility exists that these taxa, often known only from very poor fragmentary specimens, are of hybrid origin, or may be unusual forms of currently extant taxa. In most cases the material appears to be sufficiently distinct to warrant recognition at some taxon level. The loss of these taxa, although not necessarily true species or subspecies, represents a loss of genetic diversity and this loss should be recorded.

2) In using the category Lower Risk Conservation Dependent (LRcd), I have interpreted this to include the conservation (preservation) of a habitat and all the diversity within that habitat, i.e. a protected area like a nature reserve or national park, rather than as a conservation programme targeted specifically at the threatened taxon concerned. This interpretation assumes that the management programme for the area would not be deleterious to the threatened taxon.

The corrections presented here pertain to the information published in the Red Data List and its first update (Hilton-Taylor 1996a, b). The additions are new records which must be added to the List. Changes in the old IUCN Red List category apply to both the local and global level, unless otherwise specified. The new IUCN Red List category only applies to the global level. Although the new South African provinces are used here, abbreviations for the old provinces are also given so that the information is comparable to that in the published List (Hilton-Taylor 1996a).

CORRECTIONS

1. *Agathosma adenandriiflora* Schltr., although susceptible to grazing in parts of its range (A. Bean pers.

comm.), has a very wide distribution and is relatively safe (D. McDonald & F. Powrie pers. comms.), therefore its status should be changed from Insufficiently Known (K) to not threatened (nt). New IUCN Red List category: Lower Risk Least Concern (LRlc).

2. Under the additions to the Fabaceae in Hilton-Taylor (1996b), number 6 was given as '*Amphithalea ericifolia* (L.) Eckl. & Zeyh. subsp. *minima* Granby'. The subspecific name '*minima*' is incorrect and should be changed to '*minuta*'.

3. *Anginon* sp. nov. (Marloth 10278 PRE). The Marloth specimen cited has been identified as *A. intermedium* I.Allison & B.-E.van Wyk ined. (Allison 1995). The conservation status of this unpublished species has not been assessed. The new species of *Anginon* which the compiler of the Red Data List had in mind is now called *A. fruticosum* I.Allison & B.-E.van Wyk ined. It is a widespread and common species and its status locally and globally should be changed to not threatened (nt) or Lower Risk Least Concern (LRlc):

4. *Angraecum chamaeanthus* Schltr., recorded as not threatened (nt) globally because of its wide distribution in Africa, is considered to be Rare (R) in Mpumalanga and Northern Province of the former Transvaal (T). The species is also known from a number of scattered localities in KwaZulu-Natal (Manning & Wright 1982; Manning 1983) where it is locally common. Status change: not threatened (nt) to Rare (R) in KwaZulu-Natal (KN). New IUCN Red List category: Lower Risk Least Concern (LRlc).

5. *Ansellia africana* Lindl. was accidentally listed as being globally Vulnerable (V). This should be changed to not threatened (nt) because although it is threatened over much of its range (Khayota 1993), there are still extensive subpopulations which appear to be safe. In terms of the new IUCN Red List categories Lower Risk Least Concern (LRlc) may appear to be the logical option, but in view of the continuing removal of plants from the wild by collectors, Lower Risk Near Threatened (LRnt) may be the better option.

6. *Athanasia capitata* (L.) L. once had a wide distribution occurring in Renosterveld vegetation on the lower mountain slopes and flats between Table Mountain and the Koue Bokkeveld Mountains, Western Cape (C). Today it is known only from a few Renosterveld remnants which are coming under increasing pressure from agricultural expansion (Low & Jones 1995). The status of this species should be changed from Indeterminate (I) to Vulnerable (V). New IUCN Red List category: Vulnerable (VU C2a, D2). It is quite likely that if subjected to a more detailed assessment that this species would be placed in a higher threatened category.

7. *Bolusiella maudiae* (Bulus) Schltr. was mistakenly thought to be endemic to KwaZulu-Natal (Stewart *et al.* 1982). The widespread tropical African species *B. imbricata* (Rolfe) Schltr., is now considered to be conspecific with *B. maudiae*, and is sunk into synonymy (Wood 1989). Under this expanded concept, *B. maudiae* is now known to occur in the Ivory Coast, Ghana, Uganda,

Kenya, Tanzania, Malawi, Zambia and South Africa. Its global status is therefore not threatened (nt) or Lower Risk Least Concern (LRlc).

8. The global status of *Catha edulis* (Vahl) Forssk. ex Endl. should be changed from a '?' to not threatened (nt) or Lower Risk Least Concern (LRlc).

9. The global status of *Cheirostylis gymnochiloides* (Ridley) Rechb.f. was incorrectly given as Insufficiently Known (K). This species has a fairly wide but disjunct range, being recorded from South Africa, Swaziland, Zimbabwe, Tanzania and Madagascar (Stewart *et al.* 1982; La Croix & Cribb 1995). It is unlikely to be threatened across this entire range, so its global status should be changed to not threatened (nt) or Lower Risk Least Concern (LRlc).

10. The status of *Corycium bifidum* Sond. should be changed from Indeterminate (I) to Endangered (E). This species occurs on the lowlands of the Western Cape (C) and is extremely difficult to find, as most subpopulations have been destroyed by agricultural activities, or the sites have been invaded by alien plants (W. Liltved pers. comm.). New IUCN Red List category: Endangered (EN B1+2cd).

11. The status of *Corycium microglossum* Lindl. should be changed from Vulnerable (V) to Endangered (E). It can no longer be found at many of its former localities in the Western Cape (C) because of habitat destruction (W. Liltved pers. comm.). The largest subpopulation is probably that at Riverlands Nature Reserve which comprises only 30 plants. New IUCN Red List category: Endangered (EN B1+2bcd).

12. *Corycium vestitum* Sweet is considered to be a synonym of *C. orobanchioides* (L.f.) Sw. (Linder in prep.), a common weedy species in the Western Cape (C). Its status locally and globally is not threatened (nt) or Lower Risk Least Concern (LRlc).

13. When *Craterostigma nanum* (E.Mey. ex Benth.) Wettst. var. *nanum* was included in the *Red Data List*, there was considerable confusion about the correct nomenclature, authorship of the name and distribution of the taxon. Fischer (1992) decided that *C. nanum* was conspecific with *C. plantagineum* Hochst. and placed it into synonymy of that species. *C. plantagineum* is a very common, widespread species occurring from India to North Yemen and across Africa from Ethiopia to South Africa. Its global status is therefore not threatened (nt), but the local status in the Eastern Cape (C) and KwaZulu-Natal (KN) remains unchanged, as all the known subpopulations appear to be those previously named as *C. nanum*. *C. plantagineum* should also be recorded as not threatened (nt) for Botswana (B), Namibia (N) and the former Transvaal (T) where it is recorded in the Northern Province, Mpumalanga and Gauteng. New IUCN Red List category: Lower Risk Least Concern (LRlc).

14. *Cryptadenia laxa* C.H.Wright was recently transferred to *Lachnaea laxa* (C.H.Wright) Beyers (Beyers 1997). Although only known from a few collections, most of which are old, it seems that this species occurs in

a restricted area on high mountains in the Western Cape (C). From the collections it also appears to be a reseeded (J. Beyers pers. comm.) and would therefore be vulnerable to frequent fires. Although the status of this species should possibly be changed, this is not done here because the status of this and all the other *Lachnaea* species will be re-assessed once the taxonomic revision of the genus is complete.

15. *Cyphostemma* sp. nov. (Abbott 1557 PRE) was recently described as *Cyphostemma rubroglandulosum* Retief & A.E.van Wyk (Retief & Van Wyk 1996). The status of Insufficiently Known (K) for KwaZulu-Natal (KN) should be changed to not threatened (nt) or Lower Risk Least Concern (LRlc), as it is considered to be fairly common and under no immediate threat (Retief & Van Wyk 1996).

16. For *Dinteranthus wilmsianus* L.Bolus subsp. *impunctatus* N.Sauer, the status of Rare (R) was omitted from under Namibia (P. Craven pers. comm.; Sauer 1978).

17. The status of *Disa begleyi* L.Bolus should be changed from Insufficiently Known (K) to Rare (R). This is a very localized species, known only from a few localities on the Hottentot's Holland Mountains, Western Cape (C). It is not possible to assign a category of threat to this species in terms of the new IUCN Red List categories, because the number and size of the subpopulations is not known. This species is only recorded after fire and there are currently very few records of it. New IUCN Red List category: Data Deficient (DD).

18. *Disa brachyceras* Lindl., although fairly widespread in the Western Cape (C), is a very scarce and seldom collected species (P. Linder pers. comm.). It is not entirely clear if the lack of records is due to it being inconspicuous (small size) or to rarity. However, given the number of recorded localities and its occurrence at high altitudes, the status of this species should be changed from Insufficiently Known (K) to Rare (R). New IUCN Red List category: a global status of Lower Risk Near Threatened (LRnt) is considered appropriate pending further population information.

19. *Disa brevipedata* H.P.Linder is known only from two collections made near Kleinmond, Western Cape (C) in 1942. As more than 50 years have elapsed without any further records of this species, the status should be changed from Rare (R) to Extinct (Ex). New IUCN Red List category: EX.

20. The status of *Disa cephalotes* Rechb.f. subsp. *frigida* (Schltr.) H.P.Linder, under KwaZulu-Natal (KN), should be changed from a '?' to Rare (R). This is a scarce high altitude taxon from the Drakensberg. New IUCN Red List category: Lower Risk Near Threatened (LRnt).

21. *Disa extinctoria* Rechb.f. has a fairly wide distribution in Mpumalanga and the Northern Province extending to Swaziland. Although it occurs in damp grasslands, a habitat under threat, there appear to be sufficient subpopulations in protected areas to ensure the safety of this species. For the former Transvaal (T) the status should be changed from Insufficiently Known (K) to Rare (R); and

for Swaziland (S) from Insufficiently Known (K) to Vulnerable (V), as only a single subpopulation is known from that area (K. Braun pers. comm.). The global status should be changed from Insufficiently Known (K) to Rare (R). New IUCN Red List category: Lower Risk Near Threatened (LRnt).

22. *Disa montana* Sond. is now known to occur in KwaZulu-Natal (KN) (Pietermaritzburg Orchid Society 1996). This species should be listed as Indeterminate (I) for that region until further information is obtained on its status. New IUCN Red List category: Data Deficient (DD).

23. *Disa ocellata* Bolus, a Rare (R) species on the Cape Peninsula (Hall & Ashton 1983), was considered to be not threatened (nt) in Hilton-Taylor (1996a) as it was also known from mountains around Paarl and from the Swartberg range (Linder 1981a). The subpopulations on Table Mountain are probably Extinct (P. Linder pers. comm.) and the species is known only from a few recent records, each comprising only one or two plants. The status of *D. ocellata* may well be Vulnerable; however, because of its apparently sporadic nature and its inconspicuous brown colouring, it should be listed as Rare (R). There is also a recent record from the Kammanassie Mountains (W. Liltved pers. comm.) which extends the known distribution of this species considerably to the east. New IUCN Red List category: Lower Risk Near Threatened (LRnt).

24. *Disa rhodantha* Schltr. also occurs in the Eastern Cape (C) where its status is Insufficiently Known (K). New IUCN Red List category: Data Deficient (DD).

25. *Disa sankeyi* Rolfe was listed as not threatened (nt) locally and globally because it was thought to have a fairly wide distribution. Current records, however, indicate that it is scarce throughout its range and can only reliably be found in a few localities. Its status in KwaZulu-Natal (KN) and Lesotho (L) should be changed to Rare (R). Its status in the Free State (O) should be changed to Indeterminate (I) as its occurrence in this province has not been confirmed since the type collection made by Sankey in the early 1900s somewhere near Harrismith (Linder 1981b). The species is also known to occur in the northeastern extremity of the Eastern Cape (C) where its status is also Rare (R). The global status is therefore Rare (R). New IUCN Red List category: Lower Risk Near Threatened (LRnt).

26. The status of *Disa subtenuicornis* H.P.Linder should be changed from Rare (R) to Vulnerable (V) as it is known only from a single subpopulation on the Langeberg above Riversdale, Western Cape (C). New IUCN Red List category: Vulnerable (VU D1, D2).

27. The area of occupancy for *Disa tenella* (L.f.) Sw. subsp. *tenella* has been greatly reduced in recent years by habitat destruction as a result of agriculture, urbanization and alien plant invasions. Its status should therefore be changed from Rare (R) to Vulnerable (V) as the species is increasingly being confined to small remnant sites. New IUCN Red List category: Vulnerable (VU B1+2bcd).

28. *Disa tysonii* Bolus has a very wide scattered distribution, which makes it difficult to evaluate its status. It

would appear that the Lesotho (L) subpopulations are threatened by overgrazing (S. Talukdar pers. comm.); its status should therefore be changed from the hybrid category R/V to Vulnerable (V). In KwaZulu-Natal (KN), it appears to be fairly localized with low numbers in each subpopulation, so its status should be changed from a '?' to Rare (R). New IUCN Red List category: Lower Risk Near Threatened (LRnt).

29. A typesetting error in Hilton-Taylor (1996a) resulted in the name of the second species of *Disperis* being cut off. The full name should read as follows: *Disperis bolusiana* Schltr. ex Bolus subsp. *macrocorys* (Rolfe) J.C.Manning.

30. Recent records indicate that *Disperis concinna* Schltr. is fairly scarce throughout its range. Its status in KwaZulu-Natal (KN) should be changed from not threatened (nt) to Rare (R). The species is known only from a single collection in Mpumalanga (T) made late last century, hence its status there should be changed from Insufficiently Known (K) to Indeterminate (I) as it is at least very Rare if not Extinct in that area. Sightings of this species in the Wakkerstroom area have been reported by amateur orchidologists; however, no positive evidence of its occurrence has been presented. The species also occurs in eastern Zimbabwe where it is Rare. The global status should therefore be changed from Insufficiently Known (K) to Rare (R). New IUCN Red List category: Lower Risk Near Threatened (LRnt).

31. *Dombeya rotundifolia* (Hochst.) Planch. var. *velutina* I.Verd. is a synonym of *D. rotundifolia* (Hochst.) Planch. (Seyani 1991). It has a wide distribution across Africa (including Botswana, Free State, Gauteng, KwaZulu-Natal, Mpumalanga, Namibia, North-West province, Northern Province, Swaziland) and is not threatened (nt) in any part of its range. New IUCN Red List category: Lower Risk Least Concern (LRlc).

32. The global status of *Ensete ventricosum* (Welw.) Cheesman was incorrectly given as Indeterminate (I). This should be changed to not threatened (nt) or Lower Risk Least Concern (LRlc) as it is a widespread species occurring across Africa from Ethiopia to the northern parts of South Africa (Baker & Simmonds 1953). It is of local conservation concern in certain areas, but is not threatened everywhere.

33. *Eulophia lolubii* Rolfe was thought to be endemic to the FSA region (Hall *et al.* 1980); however, it is now known to occur in Angola, Zambia and Zimbabwe (Hall in prep.). Although its status has not been evaluated in these other countries, it is unlikely to be threatened throughout its range. The global status should therefore be changed from Indeterminate (I) to not threatened (nt) or Lower Risk Least Concern (LRlc).

34. *Eulophia leachii* Greatrex ex A.V.Hall has a highly scattered distribution, occurring in Namibia, South Africa (KwaZulu-Natal, Mpumalanga, Northern Province) and Zimbabwe. In all these regions, only a few localities are known although the species was recorded as forming large colonies (Hall 1965). Many of these localities have been transformed by agricultural activities in recent years. The global status was given as

Vulnerable (V), but as the status in most of the above areas is Indeterminate (I) the global status should also be changed to this. New IUCN Red List category: Data Deficient (DD).

35. *Euphorbia berotica* N.E.Br. is not endemic to the FSA region; it occurs in Angola where, judging by its scattered distribution, it appears to be Rare (R) (Leach 1975).

36. A subspecies of *Euphorbia grandicornis* Goebel ex N.E.Br. (subsp. *sejuncta* L.C.Leach) occurs in Mozambique, therefore the name of the taxon listed should be corrected to subsp. *grandicornis*. This taxon also occurs in Mpumalanga and on the borders of the Northern Province (T) where it is considered to be not threatened (nt). New IUCN Red List category: Lower Risk Least Concern (LRlc).

37. *Euphorbia hottentota* Marloth also occurs in Namibia (N) (Williamson 1996) where it is considered to be Rare (R).

38. For *Gardenia thunbergia* L.f., the author name should be changed from L.f. to Thunb., as *G. thunbergia* L.f. is a later homonym.

39. The status of *Habenaria bicolor* Conrath & Kraenzl. in Swaziland (S) should be changed from Insufficiently Known (K) to Indeterminate (I) as there appear to be no recent records from that area. The species also occurs in Zimbabwe where it is Rare (R), hence its global status remains unchanged.

40. The status of *Habenaria kraenzliniana* Schltr. in KwaZulu-Natal (KN) should be changed from a '?' to Insufficiently Known (K). There appear to be no recent collections of this species from that area, but further information is required before assigning a higher threatened status.

41. In Hilton-Taylor (1996b) the spelling of *Haworthia mcmurtryi* C.L.Scott was corrected to *H. macmurtryi* in accordance with ICBN Article 60C.4. However, Scott (1996) correctly points out that this is not an Article but a Recommendation and that because he intended the name to be spelt without the 'a', *mcmurtryi* is orthographically correct.

42. The status of *Herschelianthe forcipata* (Schltr.) Rauschert should be changed from Indeterminate (I) to Extinct (Ex), as it has not been recorded again since the type collection was made somewhere in the southern Cape (C) last century. New IUCN Red List category: EX.

43. The status of *Herschelianthe lugens* (Bolos) Rauschert var. *nigrescens* (H.P.Linder) N.C.Anthony should be changed from Indeterminate (I) to Endangered (E) as indicated by Everard (1988). This taxon is known only from a single locality in the Eastern Cape (C) comprising one subpopulation of probably less than 50 plants (Linder 1989). The population was protected by the owners (Linder 1989), but any change in ownership and subsequent development would result in the extinction of this taxon. New IUCN Red List category: could be

Critically Endangered, but as no recent population information is available it is best classified as Endangered (EN C2b, D).

44. The status of *Herschelianthe newdigatae* (L.Bolus) N.C.Anthony should be changed from Insufficiently Known (K) to Vulnerable (V). The species may even be Endangered as it is only known from a few collections made in the area between Nature's Valley and Plettenberg Bay, Eastern Cape (C). Expanding developments in this area have probably affected this species. New IUCN Red List category: Vulnerable (VU D1, D2).

45. *Herschelianthe venusta* (Bolos) Rauschert has a wide but very disjunct distribution, being recorded in the Western Cape (C) from the Cape Peninsula and Betty's Bay–Hermanus area, and then on the Hogsback Mountains in the Eastern Cape. The Cape Peninsula subpopulations are probably Extinct because of urban expansion and the Betty's Bay–Hermanus subpopulations have also been severely affected by coastal developments. No additional records have been obtained from the Eastern Cape. The status of this species should be changed from Insufficiently Known (K) to Vulnerable (V). New IUCN Red List category: Vulnerable (VU D1, D2).

46. *Holothrix culveri* (Schltr.) Bolus is known only from the type collection made by Culver in September 1890 near Barberton in Mpumalanga (Immelman 1996). As this distinctive species has not been recollected for more than fifty years, its status locally (T) and globally should be changed from Insufficiently Known (K) to Extinct (Ex). New IUCN Red List category: EX.

47. *Holothrix longicornu* G.J.Lewis, which apparently occurred in the Port Elizabeth area of the Eastern Cape (C), has not been recollected for more than fifty years (Immelman 1996). The Port Elizabeth area has been relatively well explored by botanists, and as much of the area has been transformed by urban developments, its status locally and globally should be changed from Insufficiently Known (K) to Extinct (Ex). New IUCN Red List category: EX.

48. The occurrence of both *Holothrix macowaniana* Rchb.f. and *H. micrantha* Schltr. in Zimbabwe (Grosvenor 1976; La Croix & Cribb 1995), was overlooked in the previous Red Data List. They are therefore not endemic to the FSA region. The status of both species in Zimbabwe is Insufficiently Known (K); the global status therefore remains unchanged.

49. *Holothrix majubensis* C. & R.H.Archer ined. has now been published (Archer & Archer 1996); the 'ined.' portion can therefore be deleted.

50. The global status of *Holothrix randii* Rendle should be changed from Insufficiently Known (K) to not threatened (nt) or Lower Risk Least Concern (LRlc). The species is known to occur in Zimbabwe (where it appears to be fairly scarce) and in Kenya and Tanzania (La Croix & Cribb 1995).

51. The presence of *Holothrix villosa* Lindl. var. *condensata* (Sond.) Immelman in the Transvaal (T) as indicated by the '?' and following Arnold & De Wet (1993), is incorrect and should be deleted (Immelman 1996).

52. *Imitaria muirii* N.E.Br. was accidentally listed and should be deleted. It is a synonym of *Gibbaeum nebrowii* Tischer, which is listed as Insufficiently Known (K).

53. *Lobostemon bolusii* Levyns and *L. inconspicuus* Levyns are considered to be conspecific with *L. capitatus* (L.) H.Buck (M. Buys pers. comm.). Although this species has a fairly wide distribution it is threatened throughout its range by habitat destruction (M. Buys pers. comm.). It is currently known only from a few very small groups of plants on the Tygerberg Hills (J. Wood pers. comm.), a single subpopulation near Wellington, a subpopulation on the Gordon's Bay flats (= *L. bolusii*) which is probably Extinct and a few scattered individuals (= *L. inconspicuus*) near Bredasdorp (M. Buys pers. comm.). This Western Cape (C) species remains listed as Vulnerable (V). New IUCN Red List category: Endangered (EN C2a, D).

54. The status of *Lobostemon collinus* Schltr. ex C.H.Wright should be changed from Rare (R) to Endangered (E) as it is currently only known from 20–30 plants in a single subpopulation straddling two farms in the Bredasdorp area (M. Buys pers. comm.). New IUCN Red List category: Critically Endangered (CR C2b, D).

55. The status of *Lobostemon gracilis* Levyns should be changed from Insufficiently Known (K) to Vulnerable (V). It is currently only known from a single subpopulation comprising 50–60 plants near Robertson (M. Buys pers. comm.). The species is not given a higher status under the old IUCN system, because the subpopulation appears to be relatively secure from agricultural activities, and other subpopulations may still survive elsewhere. However, any agricultural activity in the area would rapidly change the *status quo*. The type locality for this species lies under the Brandvlei Dam (M. Buys pers. comm.). New IUCN Red List category: Endangered (EN C2b, D).

56. *Lobostemon horridus* Levyns is now considered to be conspecific with *L. paniculatus* (Thunb.) H.Buck (Buys & Van der Walt 1997). *L. paniculatus* is a common fairly widespread species in the Western Cape (C) which should be listed as not threatened (nt) or Lower Risk Least Concern (LRLc).

57. The status of *Lobostemon lucidus* (Lehm.) H.Buck should be changed from Insufficiently Known (K) to Rare (R). Only two subpopulations are known, but both are large and one is in the De Hoop Nature Reserve (M. Buys pers. comm.). New IUCN Red List category: Lower Risk Conservation Dependent (LRcd) is probably appropriate, provided that the total number of mature plants exceeds 1000 individuals.

58. The status of *Lobostemon muirii* Levyns should be changed from Insufficiently Known (K) to Rare (R). Only two subpopulations of this species are currently known, both on the northern slopes of the Langberg. Although the populations are small they do not appear to be under any immediate threat (M. Buys & D. McDonald pers. comm.). New IUCN Red List category: Vulnerable (VU C2a, D2).

59. *Merremia dissecta* (Jacq.) Hallier f. is incorrectly listed as an endemic Rare (R) species from KwaZulu-Natal (KN). The occurrence of this taxon is an error which has been perpetuated since the publication of *The Flora of Natal* (Ross 1972: 295). It is an introduced species from the Americas which was grown in the Durban Botanic Garden (Welman 1997) and should be regarded as not threatened (nt). A new IUCN Red List category is not appropriate here as the species is not indigenous to the region.

60. The status of *Monadenia pygmaea* (Bolus) T.Durand & Schinz should be changed from Insufficiently Known (K) to Rare (R). It occurs mainly on the flats between the Cape Peninsula and Bredasdorp. Much of the lowland habitat is lost or disappearing, but good subpopulations can still be found in some areas after a fire. New IUCN Red List category: Lower Risk Near Threatened (LRnt); as habitat destruction continues, it will probably move into the Vulnerable category in the near future.

61. *Mossia intervallaris* (L.Bolus) N.E.Br. was recorded in Hilton-Taylor (1996a) as occurring in the Transvaal only. This is incorrect, as there are historical and recent records from other provinces (Smith *et al.* 1997). Unfortunately, Smith *et al.* (1997) do not provide any information on the number or size of the extant populations, but they do state that they consider it to be a Rare species which is at risk from unexpected threats such as extensive granite mining. Given this information, the status and distribution of the species should be amended as follows: Rare in the Eastern Cape (C), Lesotho (L), Free State (O), Gauteng and Mpumalanga (T). It is difficult to evaluate the species in terms of the new IUCN Red List categories; however, given its fairly wide distribution range and the high probability that it may occur at other sites and that it is known to occur in a conservation area, its classification as Lower Risk Near Threatened (LRnt) seems appropriate. Field assessment of all the known localities is required to confirm this. It should also be noted that a proposal to conserve the generic and species names against earlier homonyms has recently been published (Smith & Hartzler 1997).

62. *Nemesia fruticans* (Thunb.) Benth. also occurs in Botswana (B), Lesotho (L), Namibia (N) and Zimbabwe and is therefore not endemic to the FSA region (Philcox 1990: 11). It is also not threatened (nt) in all these countries. New IUCN Red List category: Lower Risk Least Concern (LRLc).

63. The spelling of the specific name of *Nerine masonorum* L.Bolus is an orthographic error and should be changed to *N. masoniorum* in accordance with ICBN Article 60.11. This orthographic error was in fact corrected by Barker (1935), but overlooked subsequently. This species is known currently only from a single locality in the Eastern Cape (C) where it is very abundant. Unfortunately this locality is being placed under increasing threat because of an expanding settlement nearby (E. Cloete pers. comm.). The species is, however, known to have occurred at other sites in the region and these need to be investigated before changing the status to a higher category.

64. The status of *Nerine platypetala* MacNeil (note author correction), for Mpumalanga (T), should be chang-

ed from a ? to Rare (R) as, although abundant, it is confined to wetlands in a very localized area (R. Archer pers. comm.). Part of the population is in a conservation area. The future of the species is very dependent on a continued wetlands conservation programme for the area (Craib 1996). The occurrence of this species in the Free State (O) has not been reconfirmed, so its status there and globally remains unchanged. New IUCN Red List category: Lower Risk Conservation Dependent (LRcd).

65. The spelling of *Othonna cakilefolia* DC. is incorrect and should be corrected to *O. cakilifolia* (Rowley 1994).

66. According to Rowley (1994), *Othonna pinnatilobata* Sch.Bip. is a synonym of *O. retrofracta* Jacq. The latter is the earliest name for what is probably a single widespread but highly variable species, rather than a number of separate species (Rowley 1994). Its status is not threatened (nt) locally (the species also occurs in Namibia) and globally. New IUCN Red List category: Lower Risk Least Concern (LRLc).

67. The status of *Oxalis couptonii* Salter in the Western Cape (C) should be changed from Insufficiently Known (K) to not threatened (nt). N. Helme (pers. comm.) has found that the species is fairly abundant (more than 1000 plants) and frequently co-occurs with *O. oculifera* (see below). New IUCN Red List category: provisionally classified as Lower Risk Near Threatened (LRnt) as it is not as abundant as *O. oculifera* and appears to be more restricted in its distribution.

68. *Oxalis extensa* Salter also occurs in Namibia (P. Craven pers. comm.) where its status is also Insufficiently Known (K). New IUCN Red List category: Data Deficient (DD).

69. The status of *Oxalis oculifera* E.G.H.Oliv. should be changed from Rare (R) to not threatened (nt). This species was known until recently only from the type locality, however, recent field work by Nick Helme on the Matsikamma Mountain in the Western Cape (C), has shown this to be a very common and abundant species. N. Helme (pers. comm.) estimates that there are over 10 000 plants and that many of these are safe from agricultural activities, particularly ploughing, as they grow in cracks and gaps between the extensive sandstone rock sheets found on the mountain. In terms of the new IUCN Red List categories, the species could qualify as Vulnerable (VU) under the D2 criterion because of its very restricted area of occupancy. However, because of the large numbers present, its capacity to reproduce vegetatively and because agricultural activities, including trampling by livestock, are unlikely to have much impact, the species is listed as Lower Risk Least Concern (LRLc).

70. *Ozoroa insignis* Delile subsp. *latifolia* (Engl.) R.Fern. is not endemic to the FSA region as it is also recorded from Angola, Cabinda and the Congo Republic (Fernandes 1966). Its status remains unchanged.

71. The status of *Pachites appressa* Lindl. should be changed from Indeterminate (I) to Rare (R). This scarce species is confined to very localized places on mountain

slopes in the Western Cape (C) but it can appear in fairly large numbers after fire. As no population size estimates are available it is difficult to evaluate this species using the new IUCN Red List categories; however, Lower Risk Near Threatened (LRnt) may be the most appropriate for now.

72. The name *Pelargonium uamaquense* Knuth should be changed to *P. bubonifolium* (Andrews) Pers. (Marais 1997). Although this species is fairly abundant, its status remains unchanged for the present because of its very localized occurrence.

73. *Petalidium crispum* A.Mecuse ex P.G.Mey. also occurs in Angola (P. Craven pers. comm.) and is therefore not endemic to the FSA region. Very little information on the species in Angola is available; its status is therefore also Insufficiently Known (K). New IUCN Red List category: Data Deficient (DD).

74. *Platylepis glandulosa* (Lindl.) Rchb.f. was incorrectly listed as *P. glandulosa* Rchb.f. The author names should be corrected.

75. *Polygala esterae* Chodat is considered by Paiva (1993) to be a synonym of *Polygala gazensis* Baker f., a widespread species recorded from Zimbabwe, Mozambique, KwaZulu-Natal (KN) and the Eastern Cape (C). Judging from the number of herbarium collections it would appear to be not threatened (nt) globally and locally, although its status in some areas may require reassessment. New IUCN Red List category: Lower Risk Least Concern (LRLc).

76. *Polygala galpinii* Hook.f. will be transferred to *Heterosauara galpinii* (Hook.f.) Paiva ined. (Paiva 1993). This is a poorly known species and until its status in Mpumalanga (T) and Swaziland (S) is checked, its global status should be corrected to Insufficiently Known (K). New IUCN Red List category: Data Deficient (DD).

77. *Polygala lasiosepala* Levyns is also recorded from the Lüderitz area in Namibia (N) (Paiva 1993). As only one collection is known so far, its status in Namibia should be Insufficiently Known (K). This species has a very unusual disjunct distribution pattern being recorded from Lüderitz, the Kamiesberg and from near Clanwilliam. All the collections are old, dating from last or early this century. New IUCN Red List category: Data Deficient (DD).

78. Paiva (1993) proposed that *Polygala microlopha* DC. var. *gracilis* Levyns be given specific status and has named it as *Polygala levynsiana* Paiva ined. Its status remains unchanged.

79. *Polygala natalensis* Chodat is considered by Paiva (1993) to be a synonym of *Polygala serpentaria* Eckl. & Zeyh. The status of this species is difficult to evaluate from the herbarium collections as none of them have been curated according to Paiva's revision. It appears to have a fairly wide but scattered distribution occurring in the Eastern Cape (C), KwaZulu-Natal (KN), Free State (O) and in Gauteng, Mpumalanga and the Northern Province of the former Transvaal (T). The occurrence of this species in threatened grassland areas

and the fact that it is offered for sale at informal medicinal plant markets in Durban (R. Williams pers. comm.) indicates that it could still be of conservation concern. The species also occurs in bushveld areas where it appears to be relatively safe (K. Balkwill pers. comm.). The local status in all the above regions and globally should therefore be changed to Insufficiently Known (K) until further information is available for assessment. New IUCN Red List category: Data Deficient (DD).

80. *Polystachya albesceus* Ridl. subsp. *imbricata* (Rolfe) Summerh. has been discovered in forests in southern KwaZulu-Natal (KN) (Pietermaritzburg Orchid Society 1996) and it should be listed as Rare (R) for that region.

81. The status of *Polystachya zuluensis* L.Bolus in Swaziland (S) should be changed from Insufficiently Known (K) to Indeterminate (I). This Lebombo endemic is known from at least two subpopulations in Swaziland and should probably be listed as Rare, but an assessment of the species in the field is required.

82. *Psoralea abbottii* C.H.Stirt. ined. is now published (Stirton 1995) and the 'ined.' portion can be deleted. The status of this species remains Rare (R) following the old IUCN Red List categories, but in terms of the new categories it would be listed as Lower Risk Conservation Dependent (LRcd).

83. The Eastern Cape (C) subpopulation of *Raspalia trigyna* (Schltr.) Dummer is now Extinct (Ex) and the KwaZulu-Natal (KN) subpopulation was also thought to be heading the same way, as the only wild plant appeared senescent (Arkell 1995). However, Arkell (1996) has subsequently discovered another healthy individual. Attempts to cross-pollinate the healthy wild plant with the four plants propagated from cuttings from the Eastern Cape subpopulation and planted in the Umtamvuna Nature Reserve, have been unsuccessful so far (J. de Lange pers. comm.). Attempts are now being made to root some more cuttings from the healthy wild plant, but initial attempts have failed (J. de Lange pers. comm.). New IUCN Red List category: Critically Endangered (CR A1a, B1+2bde, C2a, D).

84. The status of *Satyrium microrrhynchum* Schltr. in KwaZulu-Natal (KN), should be changed from a '?' to Rare (R). There are an increasing number of records from KwaZulu-Natal, but usually only of single plants. This is a high altitude species occurring along the Drakensberg escarpment from the Eastern Cape (C) to Mpumalanga (T). Records in the latter area are also very scarce; therefore its status under 'T' should be Insufficiently Known (K). New IUCN Red List category: Data Deficient (DD).

85. *Satyrium princeps* Bolus occurs on coastal dunes between Wilderness and Port Alfred in the Eastern Cape (C), however, most of the subpopulations have been destroyed by coastal developments or through invasions by alien plant species (J. Vlok & W. Liltved pers. comms.). The status should be changed from Indeterminate (I) to Vulnerable (V). New IUCN Red List category: Vulnerable (VU B1+2acd). This species could well become Critically Endangered if no subpopulations occur in a conservation area.

86. Hall (1982) considered *Satyrium rhodanthum* Schltr. to be a hybrid species (*Satyrium longicauda* Lindl. var. *longicauda* × *S. neglectum* Schltr. subsp. *woodii* (Schltr.) A.V.Hall) because it was only known from a single subpopulation at the time. Two new subpopulations have since been found (G. Mardon pers. comm.) some distance from the first, and the available evidence suggests that *S. rhodanthum* should be recognized as a true species (H. Kurzweil pers. comm.). The original subpopulation and one of the other new ones have both been destroyed by afforestation for commercial timber plantations (G. Mardon pers. comm.). The only subpopulation known to survive comprises approximately 1000 plants, and it too is under threat from afforestation (G. Mardon pers. comm.). The name of this species should be reinstated and its status changed from not threatened (nt) to Endangered (E) in KwaZulu-Natal (KN) and globally. New IUCN Red List category: Endangered (EN B1+B2abde, C2b).

87. The status of *Schizochilus ceciliae* Rolfe subsp. *transvaalensis* (Rolfe) H.P.Linder should be changed from Insufficiently Known (K) to Rare (R). Although it has a fairly wide distribution along the Drakensberg escarpment in Mpumalanga and the Northern Province (T) some subpopulations have been affected by afforestation. New IUCN Red List category: Lower Risk Conservation Dependent (LRcd). If the escarpment is not protected against further afforestation and development this species will rapidly move into a higher category.

88. The status of *Schizochilus crenulatus* H.P.Linder should be changed from Insufficiently Known (K) to Vulnerable (V). This species has a restricted distribution, occurring in a small area on the Drakensberg escarpment in Mpumalanga (T). It grows in a very sensitive habitat on the edges of Black Reef Quartzite rock flushes, in damp conditions, usually in association with moss (Linder 1980). Afforestation of the surrounding grasslands will undoubtedly affect these seepages as will further tourist developments at places such as Mac Mac Falls. New IUCN Red List category: Vulnerable (VU D2).

89. *Schizochilus lilacinus* Schelpe ex H.P.Linder, confined to a small area near Lydenburg, Mpumalanga (T), should have its status changed from Insufficiently Known (K) to Vulnerable (V). Afforestation of the grasslands in this area is posing a threat to this species. New IUCN Red List category: Vulnerable (VU D2).

90. A series of short notes culminating in a recent overview of the taxa in the genus *Schwantesia* (Zimmermann 1996a) has enabled a re-assessment of the status of the taxa listed as threatened. *S. acutipetala* L.Bolus, although abundant, occurs in a fairly confined area, so its status should be changed both locally and globally from the hybrid category of Rare/Vulnerable (R/V) to Rare (R) or Lower Risk Near Threatened (LRnt). The status of *S. borcherdsii* L.Bolus, *S. pillansii* L.Bolus and *S. ruedebschii* Dinter remains unchanged. The information and status for *S. succumbens* (Dinter) Dinter, need to be corrected. *S. speciosa* L.Bolus, was listed as a synonym of *S. succumbens* (Hilton-Taylor 1996a), but until conclusive evidence for this specificity is obtained, the two taxa should rather be consid-

ered separately (Zimmermann 1996a). *S. succumbens* is a relatively poorly known species which at this stage appears to be endemic to Namibia (N) (Zimmermann 1996a). Its scarcity (it has only ever been collected twice, once in 1924 and again in 1994) and localized nature indicate that it should be given a status of Rare (R). *S. speciosa* on the other hand, was previously considered to be threatened (Hall & Veldhuis 1985), but is now known to occur in fairly large subpopulations in the Northern Cape (C) and should therefore be regarded as not threatened (nt) or Lower Risk Least Concern (LRlc). The search for *S. succumbens* resulted in the discovery of a new and scarce species which is added to the list (see below). *S. triebneri* L.Bolus, is considered to be a synonym of *S. pillansii* (Zimmermann 1996a), so should be deleted from the list. As complete information on population numbers, sizes, and distribution is not yet available, all these taxa have not been evaluated in terms of the new IUCN Red List categories.

91. The name *Senecio expansus* Harv. was found to be a later homonym and the species was therefore renamed as *S. anapetes* C.Jeffrey (Jeffrey 1992). The name should be corrected and its status remains unchanged.

92. The status of *Siphonochilus aethiopicus* (Schwein.) B.L.Burt under KwaZulu-Natal (KN) should be changed from Endangered (E) to Extinct (Ex) as it has not been collected in the wild since the turn of this century (Gordon-Gray *et al.* 1989). It seems likely that *S. aethiopicus* was introduced into Swaziland and KwaZulu-Natal as a cultivated plant (Williams *et al.* 1996).

93. The taxonomic affinities of *Sonderina streyi* Merxm. have been investigated (Allison 1995) and the species is now included under the genus *Anginon* as *A. streyi* (Merxm.) Allison & B.-E.van Wyk ined. Its status remains unchanged.

94. *Staavia brownii* Dummer, was known until recently from only four old collections (the last being in 1952), two of which were from unknown localities. Attempts to relocate the species by several botanists proved unsuccessful and it was listed as Extinct (Ex) in Hilton-Taylor (1996a). It is interesting to note that Dummer in his description of the species (1912: 29) commented '...it is significant that in recent years this plant has not been rediscovered, despite its reputed size and its occurrence on the Hottentot's Holland Range, a locality favoured by many field-botanists, which suggests that, like many other endemic types, it has suffered extinction'. A new subpopulation of approximately 400 plants was recently discovered by Mark Johns in a 3 ha area within the boundaries of the Kogelberg Nature Reserve, Western Cape (C). The plants, unless in flower, are very inconspicuous, and could easily be overlooked, so there is a strong possibility that other subpopulations may exist. Unfortunately, the area where the species was found is an ideal site for a dam and the species would be inundated if such a dam were ever built. Despite this exciting rediscovery, the status of the species is by no means secure and its status should only be changed from Extinct (Ex) to Endangered (E). New IUCN Red List category: Endangered (EN C2a).

95. The status of *Thesium davidsoniae* Brenan should be changed from Insufficiently Known (K) to Rare (R). This is a dolomite endemic from the Pilgrim's Rest area in the Northern Province (T). Although it is very localized it is apparently fairly common and under no immediate threat (P. Burgonye pers. comm.). New IUCN Red List category: Lower Risk Near Threatened (LRnt); any change in land use could push this species into a threatened category.

96. The status of *Thesium gracilentum* N.E.Br. under Swaziland (S) should be changed from a '?' to Insufficiently Known (K).

97. The status of *Thesium jeaniae* Brenan under KwaZulu-Natal (KN) should be changed from a '?' to Insufficiently Known (K). This species was erroneously recorded as occurring in the Transvaal, so the 'K' under 'T' should be deleted. New IUCN Red List category: Data Deficient (DD).

98. *Thesium leptocaulis* Sond. was thought to be only known from the Uitenhage-Port Elizabeth area in the Eastern Cape, but according to herbarium records is now considered to be widespread and fairly common in both the Eastern and Western Cape (C). Its status should be changed from Insufficiently Known (K) to not threatened (nt). New IUCN Red List category: Lower Risk Least Concern (LRlc).

99. *Tridentea marientalensis* (Nel) L.C.Leach subsp. *marientalensis* also occurs in Namibia (N) where it is not threatened (nt) (P. Craven pers. comm.) and in Botswana (B) where its status is not known (?). Its global status remains unchanged. New IUCN Red List category: Lower Risk Least Concern (LRlc).

100. The status of *Tritoniopsis elongata* (L.Bolus) G.J.Lewis should be changed from Indeterminate (I) to Vulnerable (V). *T. elongata* is confined to only a few Renosterveld fragments on the Western Cape (C) lowlands in the Paarl-Wellington area. One of these remnant patches at Joostenbergkloof was recently ploughed (Hilton-Taylor 1996c). New IUCN Red List Category: Vulnerable (VU B1+2bcd, D2).

101. *Tromotriche aperta* (Masson) Sweet also occurs in Namibia (N), but as it is only known from a single locality, its status for that region is Rare (R). The global status remains unchanged. New IUCN Red List category: Lower Risk Least Concern (LRlc).

102. The occurrence of *Tromotriche ruschiana* (Dinter) Bruyns in the Cape (C) is incorrect and should be deleted. The species is endemic to Namibia (N).

103. The description of *Tylecodon sulphureus* (Toelken) Toelken var. *armianus* Van Jaarsv. was overlooked when compiling the *Red Data List* (Van Jaarsveld 1990). The species listed in Hilton-Taylor (1996a) as Rare (R) is the typical variety and because it is fairly common and not under any threat (E. van Jaarsveld pers. comm.), should be reclassified as not threatened (nt). *T. sulphureus* var. *armianus* is also not threatened (E. van Jaarsveld pers. comm.). The new IUCN Red List category for both of these taxa is Lower Risk Least Concern (LRlc).

104. The synonym *Urginea minor* A.V.Duthie was accidentally listed in Hilton-Taylor (1996a) as Indeterminate (I) despite being included in the list of synonyms (see Appendix 3). It should therefore be deleted. The correct entry is under *Drimia minor* (A.V.Duthie) Jessop.

105. *Watsonia strictiflora* Ker Gawl. is known to have occurred in Renosterveld vegetation at several sites on the lower mountain slopes and flats between Stellenbosch, Durbanville and Paarl, Western Cape (C). As most of the localities where the species previously occurred had been transformed by cultivation and urban development, Hall & Veldhuis (1985) listed the status of this species as Unknown (K). Following the information presented in Goldblatt (1989) and the lack of recent collections, Hilton-Taylor (1996a) changed the status to Indeterminate as it was certainly highly Endangered if not Extinct in the wild. Dr Clive McDowell recently discovered a small subpopulation of *W. strictiflora* on the farm Joostenbergkloof (see Hilton-Taylor 1997). A subsequent visit to the site by Dr Peter Goldblatt and myself confirmed this discovery and we counted approximately 200 plants in the remaining Renosterveld fragments. The future of these fragments is very precarious at present as the owner has requested permission to continue with the agricultural development of the land. If the farmer is granted permission, only a few plants on the rocky outcrops may be protected from ploughing activities. The status of this species should be changed to Endangered (E). New IUCN Red List category: Critically Endangered (CR B1+2bcde, C2a).

106. A specimen of *Zeuxine africana* Rchb.f. was recently collected in Botswana (La Croix & Cribb 1995), thereby extending the known distribution of this enigmatic species (also recorded from Angola, Nigeria and South Africa). Its status in Botswana (B) should be recorded as Insufficiently Known (K). In all cases, the species is only known from one or two collections, indicating its possible rarity. The global status should be changed from Indeterminate (I) to Insufficiently Known (K) pending further information. New IUCN Red List category: Data Deficient (DD).

ADDITIONS

Aizoaceae

1. *Schwantesia constanceae* N.Zimm. is a Rare (R) species known only from one locality near Warmbad in southern Namibia (Zimmermann 1996b). New IUCN Red List category: Vulnerable (VU D1+2).

Apiaceae

2. *Anginon tenuior* I.Allison & B.-E.van Wyk ined. is a Vulnerable (V) species recorded only from the Oudeberg Pass area near Montagu, Western Cape (C) (Allison 1995). It was possibly once widespread in Renosterveld, but only a single subpopulation of approximately 30 plants is known today (B.-E. van Wyk pers. comm.). New IUCN Red List category: this species qualifies for Critically Endangered (CR C2a, D), however, the subpopulation seems fairly secure, therefore Endangered (EN C2a, D) is probably a better reflection.

3. *Anginon ternatum* I.Allison & B.-E.van Wyk ined. is a Vulnerable (V) species known only from two localities (Gifberg and Heerenlogementsberg) in the Western Cape (C) (Allison 1995). The Gifberg subpopulations have probably been affected by agricultural activities, as only a single small subpopulation is known from there today and no plants could be found at Heerenlogementsberg during a recent survey (B.-E. van Wyk pers. comm.). New IUCN Red List category: Vulnerable (VU B1+2bcde, C2a, D1+2).

Ericaceae

4. *Stokoeanthus chionophilus* E.G.H.Oliv. is a Vulnerable (V) species confined to a single locality on the Hottentot's Holland Mountains above Somerset West, Western Cape (C). There are two subpopulations, one on the lower slopes comprising a few scattered plants and a much larger one 110 m higher up the slope (Oliver 1976). In total there are probably fewer than 1000 plants of this reseeding species (E. Oliver pers. comm.). Although safe from most human activities, this species is susceptible to frequent fires and has been burnt at least three times in the last fifteen years (E. Oliver pers. comm.). A third subpopulation was probably destroyed by fire. New IUCN Red List category: Vulnerable (VU C2a, D1+2).

Fabaceae

5. *Liparia racemosa* A.L.Schutte ined. is a Rare (R) species from the Great Swartberg Mountains in the Western Cape (C). Although a high altitude species, it is sensitive to frequent burning (Schutte 1995). New IUCN Red List category: Vulnerable (VU D2).

Orchidaceae

6. *Disa alicola* H.P.Linder, is a Vulnerable (V) species known only from a few localities on the Drakensberg escarpment between Sabie and Lydenburg, Mpumalanga (T). It occurs in damp grassland in secpages and wet hollows (Linder 1981a). The species is threatened by afforestation. New IUCN Red List category: Vulnerable (VU C2a).

7. *Disa amoena* H.P.Linder is a Vulnerable (V) species restricted to the Mt Mauch–Mt Anderson area of Mpumalanga (T). Occurs in well-drained grasslands (Linder 1981a). Three of the known subpopulations are threatened by afforestation. New IUCN Red List category: Vulnerable (VU C2a, D2).

8. *Disa cedarbergensis* H.P.Linder is a Rare (R) species known only from the type collection made in 1987 in the Cedarberg Mountains, Western Cape (C) (Linder 1988). Only a single plant was found, but as Linder (1988) points out, this may be due to the fact that it was two years after a fire and species in this group generally flower only in the first year after a fire. It is difficult to evaluate the conservation status of this species in terms of the new IUCN Red List categories, because the size and extent of the population can only be determined after a fire. This area was partially burnt in 1994, so it is likely to be many years before the next fire. The information available at present would result in a classifica-

tion of Critically Endangered (CR B1+3d, C2b, D); however, as this is not a true reflection, Data Deficient (DD) will have to suffice.

9. *Disa clavicornis* H.P.Linder is a Vulnerable (V), possibly even Endangered species known only from two collections made on Mt Anderson in Mpumalanga (T) (Linder 1984). Much of this mountain is now planted under pines (C. Archer pers. comm.); unless subpopulations are found elsewhere, this species could therefore be facing extinction. New IUCN Red List category: Vulnerable (VU C2a, D2).

10. *Disa cochlearis* S.D.Johnson & Liltved ined. is a Vulnerable (V) species known only from the Elandsberg range north of the Swartberg in the Western Cape (C) (Johnson & Liltved in press). Only three plants were found, hence the status given to this species. It could, however, occur elsewhere in this poorly explored area. The new IUCN Red List category, on the basis of current knowledge, should be Critically Endangered (CR C2b, D), but Vulnerable (VU C2a, D1) seems more appropriate.

11. *Disa introrsa* Kurzweil, Liltved & H.P.Linder ined. is a Rare (R) species known only from the Skurweberg, Western Cape (C). Only two subpopulations are known, each comprising approximately 20 individuals (Kurzweil *et al.* in press). The plants only flower in the first year after fire, so may be commoner than present records indicate. As seed-set was very good, there was hopefully some recruitment (H. Kurzweil pers. comm.). On the basis of current knowledge, the new IUCN Red List category should be Critically Endangered (CR C2a, D), but Vulnerable (VU C2a, D1) seems more appropriate.

12. *Disa maculomarronina* McMurtry is an Endangered (E) species known only from two subpopulations comprising approximately 150 plants near Graskop, Mpumalanga (T) (McMurtry 1984). This taxon was initially thought to be a hybrid, *D. versicolor* Rchb.f. \times *D. hircicornis* Rchb.f. (Linder 1981a). Despite its possible hybrid origin, this taxon is now considered to be sufficiently distinct for recognition at specific level (McMurtry 1984; Linder & Kurzweil in prep.). It grows on the edges of Black Reef Quartzite in seepages amongst moss (P. Linder pers. comm.). This is a very sensitive habitat which is threatened by afforestation, increasing tourist activity and associated developments in the area (P. Linder pers. comm.). New IUCN Red List category: Endangered (EN C2a, D).

13. *Disa virginalis* H.P.Linder, S.D.Johnson & Liltved ined. is a Rare (R) species known only from a fairly limited area on mountains in the Western Cape (C) (Linder *et al.* in press). At least one subpopulation is threatened by agricultural activities. In terms of the new IUCN Red List categories, it qualifies as Vulnerable (VU C2a).

14. *Eulophia chlorantha* Schltr. is a Rare (R) species which is confined to the mountains of northwestern Swaziland (S) and Mpumalanga (T). Habitat destruction is probably posing an increasing threat to this species. New IUCN Red List category: Lower Risk Near Threatened (LRnt).

15. *Habenaria mossii* (G.Will.) J.C.Manning is an Endangered (E) species apparently endemic to Gauteng (T) where it is known only from a few localities west of Johannesburg and near Pretoria. Two of the known localities have been destroyed by urban expansion and a third by the construction of an airfield. If not under the airfield, this locality may be in privately owned conservation area and similarly with the other two remaining sites. Although in conservation areas, the long term future of these sites is not secure. In addition there have been no recent collections of this species. New IUCN Red List category: Endangered (EN B1+2bd, C2a).

16. *Satyrium pulchrum* S.D.Johnson & Kurzweil ined. is a Rare (R) species from the Knersvlakte near Vanrhynsdorp, Western Cape (C) (Johnson & Kurzweil in press). No threats are known to this highly localized species. In terms of the new IUCN Red List categories a status of Endangered could be given, however, Vulnerable (VU C2b, D1+2) is considered more appropriate as this species was only recently discovered.

17. *Schizochilus cecilii* Rolfe subsp. *culveri* (Schltr.) H.P.Linder. should be added to the list as another Rare (R) species from the mountains of northwestern Swaziland (S) and Mpumalanga (T). Habitat destruction is posing an increasing threat to this species. New IUCN Red List category: Lower Risk Near Threatened (LRnt).

Proteaceae

18. *Serruria lacunosa* Rourke, is an Endangered (E) species which was only discovered for the first time in 1993 on the Matsikamma Mountains in the Western Cape (C) (Rourke 1996). The species was known only from four subpopulations comprising a total of approximately 52 plants (Rourke 1996; N. Helme pers. comm.). Other subpopulations may have been destroyed by farming activities especially ploughing for the propagation of rooibos tea. Since its discovery, 26 plants have died before producing any viable seed and all the remaining plants are very young (N. Helme pers. comm.), so it will be some time before there is any further recruitment. The current owners of the farms where *S. lacunosa* occurs are conservation-minded and will help ensure the protection of this species. Using the original data, the new IUCN Red List category would have been Endangered (EN B1+2c, D), however, the subsequent decline in numbers now qualifies it for it Critically Endangered (CR C2a, D).

SUMMARY

The numerous changes in status and the additions to the Red Data List mean that the statistics on the number of taxa in each threatened category updated in Hilton-Taylor (1996b) need to be revised again. The number of extinctions (Ex) have increased to 62, 277 taxa are Endangered (E), 445 Vulnerable (V), 1 446 Rare (R), 361 Indeterminate (I) and 883 Insufficiently Known (K). The numbers in the last two categories have dropped as a result of re-assessments, some have moved to a higher category while many have been removed as not threatened (nt). Twenty taxa were added to the list while 23 were removed. Although all the threatened categories have shown marked increases, the total number of taxa

listed as globally threatened in the FSA region has dropped slightly to 3474. No figures are presented for the new IUCN Red List categories, as it is premature to do so here.

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Book Review

FLORA OF GREAT BRITAIN AND IRELAND, Volume 5: Butomaceae–Orchidaceae by PETER SELL & GINA MURRELL. 1996. Cambridge University Press, The Pitt Bldg, Trumpington St. Cambridge CB2 1RP, UK. Hard cover: ISBN 0 521 55339 3, price £60.00 (US\$ 100.00).

As a South African in the plant taxonomy business, even though theoretically retired, how can I be but green with envy when I see that, even before the printers ink of the latest British flora (Stace 1991) is quite dry (considered in usual Flora time scale), there is a new one (that is, one-fifth of it) on my table. For someone not so familiar with the plant taxonomy scene in this deeply southern part of the globe, I shall explain that flora writing in this region is in a semi-dormant state: there are some specialists ploughing their field but the vogue is data crunching, not comprehensive data searching and evaluation. Aren't computers marvellous? Pity, they can't do research. Computer fundis, go for it!

The question may be asked why it should be necessary to produce a new flora for Britain and Ireland after only five or six years. The reasons are clearly and convincingly set out in the Foreword by S.M. Walters, the Preface and the Introduction. We gather that some 20 years ago a project under the leadership of Professor David Valentine to write an entirely new critical flora of Great Britain and Ireland failed to find financial support. Two champions of that project succeeded in bringing it to fruition, or at least part-fruition, till all five volumes of the new Flora are out. The first was Clive Stace with his *New Flora of the British Isles* (1991), the second Peter Sell senior author of the present work. Stace's Flora brought about the end of the era during which the *Flora of the British Isles* (1952) by Clapham, Tutin & Warburg, with several much revised later editions, was the standard work. Stace had set himself the aim to include all taxa that the botanist might reasonably be able to find in the wild in any one year. He fitted his work into a single volume and gave only abbreviated descriptions and omitted the large apomictic genera and most of the infraspecific variants. The present Flora deals with all native species, including, for the first time, full accounts of all the large apomictic genera, many infraspecific variants and all the introduced plants given in Stace (1991), with a few more added, particularly planted trees. It came to me as a major surprise that the British flora comprises almost as many alien species as native ones. The mind boggles to think what a flora of some 40 000 species in this part of the world might look like in the year 2200.

In the opinion of Sell (in the Preface) 'Stace's flora is an excellent field guide ... but it does not give the detailed descriptions which are needed to confirm the identification of a plant which is new to you'. He continues: 'a good description in my opinion is one in which a picture of the plant unfolds before you as you read it'. Sell describes how he, sitting at the microscope, dictated the descriptions, and how his co-worker, Gina Murrell, put them straight into the computer (10 years ago one would have said 'a' computer). The computer may have been used to data-base and to typeset the descriptions, it was obviously not used to generate them.

The plant divisions included in the complete flora are Lycopodiophyta (clubmosses), Equisetophyta (horsetails), Peridophyta (ferns), Pinophyta (conifers) and Magnoliophyta (flowering plants). The classification follows largely that of Stace (1991) and Kent, *List of vascular plants of the British Isles* (1992) which is based on A. Cronquist, *An integrated system of classification of flowering plants* (1981). The page size is about 165 × 245 mm and the text, including all keys and descriptions, is set in double columns. With a column width of 73 mm the side margins are obviously not meant to be used for marginalia but may allow just enough space for one rebind. Considering the excellent binding of the book, this should, however, not become necessary. The text is set in Times type, descriptions and general text in 10 pt, keys, synonymy, literature references and index in 8 pt.

The Introduction includes maps of the British Isles showing some relevant geographical features and the vice counties which are the

smallest geographical units given in the notes on distribution under every species. Considering the relatively small size of the vice counties, it is not necessary for a work of this nature to make use of a grid square system. A conspectus of families shows the arrangement of families in the five projected volumes. Given this well set out representation of the Cronquistian 'natural' arrangement of plant groups, one wonders whether the families could not have been arranged alphabetically within the major groups for easier reference by the less informed. But that would obviously reduce the need/opportunity to become familiar with the relationship of families à la Cronquist. The conspectus is followed by an artificial key to the families dealt with in the volume: 149. Butomaceae–176. Orchidaceae, in other words, the complete Liliopsida. The keys in the volume are of the bracketed type and are dichotomous throughout. As a first test object I chose the lily-of-the-valley, one of the easier plants in Britain to conjure up in one's mind. It ran very smoothly down to the family which keys out eight times. The Poaceae (what does Kew think of these 'modern' names?) was equally easy to arrive at, even though it occurs only twice in the key. It surprised me, as often before, that grasses in Europe are mostly said to have hollow internodes whereas even in the same species, in this part of the world, they tend to be solid. The keys in general appeared to be user-friendly and I did not notice a single 'not as above'; but we are not informed after a long jump where we came from. Tracing your steps back in a long key is therefore less easy. It is best to begin again at the beginning, especially as there are no megataxa in the region. Family descriptions vary in length from about 60 words in small families to almost half a page in the Poaceae, by far the biggest family in the volume, with 92 genera. Authorities are given for the names of all taxa. The synonymies are comprehensive as the authors have attempted to include all names used in British and Irish floras. Literature consulted is cited in full under each genus. English names are given for all species, following Stace (1991), and where new ones were needed, they have been created. Such action would be considered a cardinal sin by many in southern Africa who presumably have still learnt plant names from their mother. No types are mentioned and no literature is cited for species. The species descriptions are image-creating, yet generally easy to compare. They vary in length from about 120 words to half a page (Orchidaceae). Separate descriptions are given for infraspecific taxa. Descriptions include information on flowering period, chromosome number and, in Orchidaceae, pollination. Information is also given on ecology and distribution (including worldwide distribution) of species and infraspecific taxa. The work ends with some pages presenting new taxa and combinations, a paragraph on abbreviations (author names according to Brummitt & Powell (1992); journals follow B-P-H) and a glossary of 10 pages text and four pages of line drawings, and an index of 30 pages, set in three columns and listing accepted names, synonyms and common names. Black and white line drawings also illustrate diagnostic features in a number of groups of plants such as the orchid genus *Dactylorhiza* (showing label-la), *Festuca* species (transverse sections of leaves) and *Carex* species (utricles).

Seeing that this review is my last contribution to *Bothalia* in the capacity of Scientific Editor, I hope I will be forgiven for having been more than somewhat garrulous (as Beverley Momberg, Technical Editor of this journal for more years than mine, would call it). Having looked for brevity and clarity for quite some years, it is fun to relax a little. I should also like to thank Cambridge University Press for regularly sending us review copies from their phenomenal crop. The present flora is another product of theirs that recommends itself to all serious workers in the field of plant taxonomy and conservation in this country. May it help to inspire taxonomists and decision makers in Africa australis to revive the vital but painstaking art of flora writing.

National Botanical Institute South Africa: list of staff and publications, 9 April 1997

Compiler: B.A. Momberg

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Fienies, C. Groundsman I. Trees/shrubs
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 Makhubela, B.J. Groundsman I. Garden maintenance
 Maqungo, D.P. Groundsman I. Cycads
 Maqungo, Ms V.L.B. Administration Aid II. Kiosk
 Maseko, N.E. Groundsman I. New development
 Mazibuko, F.E. Groundsman I. Garden maintenance
 Mdluli, M.B. Machine Operator
 Mdluli, M.E. Groundsman I. Kiosk
 Mkhathshwa, Mrs N.S. Groundswoman II. Garden maintenance

Mteto, E.M. Groundsman I. Commercial nursery
 Musweli, K.J. Specialist Groundsman. New development
 Ndlovu, L.D. General Foreman. Maintenance
 Ngomane, S. Groundsman I. Cycads
 Ngqani, Mrs L.S. Administration Aid I
 Ngwengoma, P.N. Driver
 Ngwenya, P.S. Groundsman II. Index nursery
 Ngwenyama, K.A. Groundsman I. New development
 Nkosi, Mrs P.B. Groundswoman I. Garden maintenance
 Nkosi, Mrs S.L. Groundswoman II. Garden maintenance
 Shabangu, M.E. Driver (H)
 Shabangu, S.L. Machine Operator
 Shabangu, W.N. Groundsman I. Garden maintenance
 Shawa, P.M. Groundsman I. Commercial nursery
 Shawe, S.A. General Foreman
 Sibule, B.F. Groundsman II. Garden maintenance
 Sibure, W.F. Groundsman I. Garden maintenance
 Sigudla, B.M. Groundsman II. Garden maintenance
 Soka, M.P. Groundsman I. New development
 Thabethe, S.S. Groundsman I. Cycads
 Tsela, T.K. Groundsman I. Garden maintenance
 Van der Walt, Mrs G.A. Senior Administration Clerk II

NATAL NBG—PIETERMARITZBURG

Tarr, B.B. N.D.(Parks & Rec. Admin.), Advanced Dip.(Adult Education). Control Technician

Busani, M.A. Tractor Driver
 Dlamini, M.N. Groundsman I
 Dlungwane, T.R. General Foreman
 Gabuza, B.A. Machine Operator
 Gates, Mrs J.E. N.D.(Parks & Rec. Admin.), N.D.(Hort.)
 Intermed.D.(Marketing Man.). Senior Technician.
Kniphofia, forest spp.
 Hlela, S.C. Groundsman I
 Mbanjwa, Z.P. Groundsman I
 Mbense, M.A. Tractor Driver
 Mncwabe, Mrs Y.A. Groundswoman I
 Mncwabe, B.P. Driver (H)
 Mpangase, S.Z. Groundsman I
 Mpulo, D.H. Machine Operator
 Mthalane, M.A. Machine Operator
 Mtolo, C. Groundsman II. Team leader
 Nkabini, A.B. Groundsman II

Nonjinge, S.H.B. Principal Scientific Officer
 Ntombela, M. Groundsman I
 Nzakwe, Z.W. Groundsman I
 Radebe, N.A. Groundsman I
 Roff, J. Groundsman II
 Sokhela, P.S. Groundsman I
 Van der Merwe, Mrs M.E.H. Senior Administration Clerk I
 Xaba, M.A. Groundsman I
 Zimu, M.J. Groundsman II
 Zimu, S.P. Groundsman I
 Zondi, E.S. Groundsman II
 Zondi, T.A. Groundsman I
 Zondo, Z. Groundsman I
 Zuma, C.J. Groundsman I
 Zuma, Mrs K.K. Administration Aid I

FREE STATE NBG—BLOEMFONTEIN

Britz, R.M. N.D.(Forestry). Control Technician

Dweba, K.D. Groundsman I. Entrance
 Eysele, Mrs J.P. Senior Administration Clerk II
 Hlaole, P. Groundsman I. Nursery
 Lekheto, M.J. Groundsman II. Garden maintenance
 Lekheto, T.S. Groundsman II. Nursery
 Lumley, M.J. Chief Scientific Officer. Nursery
 Mabula, S.K. Groundsman I. Maintenance
 Masheane, D. Tractor Driver
 Mbolekwa, L.M. Groundsman II. *Rhus*, display
 Mogale, A.O. Technician. Garden
 Mohokare, L.J. Groundsman I. Garden maintenance
 Moima, T.J. Groundsman II. Braai area, maintenance

Mopeli, M.J. Groundsman I. Bulb area
 Moticoe, Mrs M.A. Groundswoman I. Nursery
 Motse, V.D. Groundsman I. General garden
 Mpeli, P.A. Groundsman I. Nursery
 Nakanyane, R.B. Senior General Foreman
 Nakedi, M.J. Driver (H)
 Olifant, D.M. Groundsman I. Kiosk area
 Radithlare, Mrs E.M. Administration Aid I.
 Sebolai, Mrs C.L. Groundswoman I. Seed room nursery
 Sebolai, R.P.A.N. Foreman. General maintenance
 Semenyane, T.D. Groundsman II. Garden maintenance
 Thaele, Mrs M.E. Administration Aid II

PRETORIA NBG

Heilgendorff, J.P. H.N.D.(Hort.). Control Technician

Baloi, R.F. Machine Operator
 Baloyi, K.J. Groundsman I. Garden records
 Baloyi, S.J. Driver (H)
 Baloyi, M.S. Dip.(IBM) Specialized Auxiliary Services
 Officer. Garden records
 Chipi, S.M. Groundsman I. Security
 Chuma, J.S. Groundsman I. Security
 Dry, D.H. N.D.(Hort.). Chief Technician. Plant sales,
 records and gate control. Technical papers on hor-
 ticulture and plants
 James, V.H. Groundsman I. General maintenance
 Kemp, J. Groundsman I. Scientific collections
 Keyter, B.A. Senior Security Officer
 Klapwijk, N.A. N.D.(Hort.), N.D.(Plant Prod.), N.D.
 (Diesel Fitting). Chief Technician. Planning and
 development. Index Nursery, New Plant Company
 Kutama, B.T. Groundsman I. Garden development
 Letsoalo, H.M. Groundsman I. Sete Team
 Mabasa, J.R. Groundsman I. Security
 Machika, S.M. Groundsman I. Irrigation
 Madlala, Ms N. N.T.C.III(Hort.), N.D.(Parks & Rec.Man.).
 Communications Officer
 Mahlangu, J.J. Groundsman I. Production nursery
 Mahlase, M.M. Groundsman I. Security
 Makafula, W.P. Groundsman I. Garden development
 Makena, M.S. Driver (H). Gate control
 Makena, S.N. General Foreman. Makena Team
 Makena, T.J. Groundsman I. Production nursery
 Makgopo, C.K. Groundsman I. Sete Team
 Makhafola, L.W. Groundsman I. Garden development
 Makhubela, D. General Foreman. Production nursery
 Makhubela, K.P. Groundsman I. Scientific collection
 Makoeng, T.P. Groundsman II. Production nursery
 Makola, M.J. Groundsman I. Makena Team
 Makola, M.L. Groundsman II. Production nursery
 Makua, E.G. Machine Operator
 Malewa, D.K. Groundsman I. Irrigation
 Malobola, J.L. Groundsman I. Sete Team
 Malobola, M. Groundsman II. Sete Team
 Maluleke, M.J. Groundsman II. Production nursery
 Mamietja, A.M. Groundsman II. Makena Team
 Mariri, J.N. Senior Genral Foreman. Maintenance

Marule, P.M. Tractor Driver
 Masango, M.G. General Foreman. Garden development
 Matchika, S.P. Groundsman I. Cook
 Mathabathe, D.S. Groundsman I. Succulents
 Matlala, S.M. Groundsman I. Makena Team
 Meyer (née Schnackenberg), Mrs H. Senior Administra-
 tion Clerk I
 Mmakujwana, K.J. Groundsman I. Garden development
 Mnyangeni, L.D. Groundsman I. General maintenance
 Modisha, M.D. Groundsman I. Cleaner
 Mogoru, F.M. Groundsman I. Makena Team
 Mogoru, S.C. Groundsman II. Sales nursery
 Mohale, F.R. General Foreman. Scientific collection
 Mohale, N.J. Groundsman I. Sete Team
 Mokawe, R.N. Groundsman I
 Molefe, J.R. Groundsman II. Makena Team
 Molokomme, K.F. Machine Operator
 Molomo, S.E. Groundsman II. Scientific collection
 Mononyane, J.B. Groundsman II. Makena Team
 Motshweni, W.V. Machine Operator
 Mudau, T.R. Groundsman I. Sete Team
 Muhali, M.B. Machine Operator
 Ngoben, R.T. Groundsman I
 Nkoane, M.J. Groundsman II. General maintenance
 Nkwana, F.N. Driver (H)
 Noko, J.M. Research Assistant
 Noku, A.Y. Tractor Driver
 Ramakgaphola, M.A. Groundsman I. Makena Team
 Ramatsetse, M.P. Groundsman II. Security
 Rampopana, A.M. Groundsman I. Production nursery
 Sete, L.B. General Foreman. Sete Team
 Shilubane, E. Storeman. Workshop
 Shirindi, J.R. Groundsman II. Cycads
 Shirindi, M.S. Groundsman I. General maintenance
 Sithole, D.J. Groundsman I. Maintenance
 Swartz, Ms P.P. M.Sc. Senior Horticulturist. Scientific
 and horticultural curation of living collections;
 garden development; seedbank of endangered
 plants and succulents; Madagascan plants
 Tefu, R.P. Groundsman I. Succulents
 Tloubatla, L.J. Groundsman I. General maintenance
 Tolo, P.K. Groundsman II. Garden development

WITWATERSRAND NBG—WILROPARK

Chaplin, P.J. N.T.C.III(Hort.). Control Technician

Hankey, A.J. N.D.(Hort.). Senior Technician.
Horticulture

Head, Mrs S.E. Senior Administration Clerk I

Khedzi, K.P. Groundsman II. Nursery

Lukhwa, N.A. Groundsman II. Garden

Luvhimbi, T.S. Groundsman I. Garden

Majamane, L. Groundsman I. Garden

Majamane, Z.E. Groundsman I. Garden

Mamosebo, M.A. Groundsman I. Garden

Manjati, Mrs N.L. Administration Aid I. Shop Assistant

Manyikana, T.A. Groundsman II. Garden

Matsea, M.W. Groundsman I. Garden

Mbulaheni, M.P. Groundsman II. Garden

Mmola, Mrs B.E. Administration Aid I. Cleaner

Mulibana, N.S. Machine Operator

Ndou, A.P. Groundsman I. Garden

Ndou, M.W. Groundsman I.

Ndwambi, N.W. Groundsman I. Garden

Ndzondo, Mrs G.P. Administration Aid I. Cleaner

Nedambale, M.P. General Foreman. Garden maintenance

Nekhavambe, S.P. Groundsman I. Garden

Nemalili, A.S. Driver (H)

Nemalili, M.E. Driver (H)

Nenungwi, M.S. Groundsman II. Nursery

Rammela, N.N. Machine Operator

Randima, M.S. Groundsman I. Garden

Raphalalani, V.S. Groundsman II. Nursery

Rossouw, P. Student

Steel, Ms B.S. N.D.(Nature Cons.), N.D.(Parks & Rec.

Admin.), Dip.(Journ.). Senior Technician. Nursery,

succulent and herb gardens, plant records

Tebeile, Ms Z.M. Administration Aid I. Shop Assistant

Thupe, G.G. Groundsman I. Garden

Thupe, I.C. Groundsman I. Garden

Tshisikule, M.G. Groundsman II. Garden

Turner, Ms S.L. B.Sc.(Hons.). Horticulture

RESEARCH DIRECTORATE

PRETORIA

Smith, Prof. G.F. Ph.D., F.L.S. Director: Research

Rutherford, M.C. Ph.D., Dip.(Datamet.). Deputy Director: Ecology and Conservation

Wolfson, Mrs M.M. Ph.D. Deputy Director: Education and Research Support

Hartzer, Mrs P.C.M. M.Sc. Chief Scientific Officer

Meyer, Mrs N.L. B.Sc.(Hons.) (contract worker)

Smit, Mrs A.C. Senior Administration Clerk II. Secretary

Steyn, Mrs E.M.A. Ph.D. Principal Scientist. Embryology

PLANT SYSTEMATICS SUBDIRECTORATE

PRETORIA

Smith, Prof. G.F. Ph.D., F.L.S. Systematics of succulents and rosulate, petaloid monocots

Arnold, T.H. Head: Data Management (Pretoria)

Koekemoer, Miss M. Curator: National Herbarium (Pretoria)

Rourke, Dr J.P. Curator: Compton Herbarium (Cape Town)

Williams, Ms R. Curator: Natal Herbarium (Durban)

Willis, C.K. M.Sc.(Cons. Biol.). Assistant Director. Project Co-ordinator: SABONET (Pretoria)

COMPTON HERBARIUM—CAPE TOWN

Rourke, J.P. Ph.D., F.L.S., F.R.S.S.Af. Assistant Director. Systematics of southern African

Beyers, Mrs J.B.P. M.Sc. Scientist. Assistant Curator:
Collections. Taxonomy of the Gnidiaceae (Thymelae-
aceae)

Cupido, C.N. B.Sc. Scientific Officer

Cupido, Mrs C.S. Specialized Auxiliary Services Officer.
Technical AssistantDavidse, Mrs. E. Specialized Auxiliary Services Officer.
Herbarium Assistant

Foster, Mrs S.E. Principal Typist I
 Holm, K. Administration Aid II
 Kurzweil, H. Ph.D. Specialist Scientist. Systematics of southern African terrestrial orchids
 Leith, Mrs J. Senior Administration Clerk I
 Manning, J.C. Ph.D. Specialist Scientist. Systematics of Iridaceae and Orchidaceae; anatomy
 Oliver, E.G.H. M.Sc. Principal Scientist. Taxonomy of the Ericoideae (Ericaceae)
 Oliver, Mrs I.M. (contract worker)

Paterson-Jones, Mrs D.A. (née Snijman) Ph.D. Principal Scientist. Systematics of Amaryllidaceae; cladistics
 Roux, J.P. N.T.C.III(Hort.), F.L.S., M.Sc. Principal Scientist. Systematics of Pteridophyta
 Steiner, K.E. Ph.D. Specialist Scientist. Systematics of Scrophulariaceae and evolutionary interactions between oil-secreting flowers and oil-collecting bees

NATAL HERBARIUM—DURBAN

Williams, Ms R. B.Sc.(Hons.), H.D.E. Chief Scientific Officer.

Bircher, Ms C.J. (contract worker)
 Crouch, N.R. Ph.D. Scientist. Ethnobotanist
 Mbonambi, B.M. Groundsman II. Garden
 Ndlovu, Ms N.C. Groundsman II
 Ngwenya, A.M. Principal Specialized Auxiliary Services Officer. Herbarium Assistant. Plant identification, plant information

Noble, Mrs H-E. Senior Administration Clerk
 Singh, Ms Y. B.Sc.(Hons.), H.E.D. Senior Scientific Officer. Taxonomy of *Zantedeschia*, plant identifications

NATIONAL HERBARIUM—PRETORIA

Koekemoer, Miss M. M.Sc. Assistant Director. Herbarium management. Taxonomy of Poaceae, Asteraceae: *Disparago*, *Stoebe*, *Amphiglossa*, *Elytropappus*, *Pterothrix* and *Bryomorpha*

Bredenkamp, Mrs C.L. M.Sc. Chief Scientific Officer. Assistant Curator: Public relations. Taxonomy of *Vitex*, *Phyllica*, Rhamnaceae, Sterculiaceae and other related families.
 Germishuizen, G. M.Sc. Principal Scientist. Assistant Curator: Finances. Taxonomy of Polygonaceae, Fabaceae, Lorantheae, Viscaceae
 Herman, P.P.J. M.Sc. Principal Scientist. Assistant Curator: Personnel. Taxonomy of Asteraceae, Flora of Transvaal
 Heymann, Mrs M.Z. T.E.Dip., B.A.(Education & History). Principal Specialized Auxiliary Services Officer. Assistant Curator: Services, loans, gifts and exchanges

Anderson, H.M. Ph.D. Principal Scientist. Palaeobotany, palaeogeography
 Anderson, J.M. Ph.D. Specialist Scientist. Palaeobotany, palaeogeography
 Archer, R.H. Ph.D. Scientist. Taxonomy of mainly Celastraceae, Euphorbiaceae
 Archer (née Reid) Mrs C. M.Sc. Senior Scientist. Taxonomy of Cyperaceae, Restionaceae, Orchidaceae
 Burgoyne, Ms P.M. M.Sc. Senior Scientific Officer. Plant identifications co-ordinator
 Cloete, Mrs M. Dip.(Typing). Senior Provisioning Clerk. Specimen label typist
 Dreyer, Miss L.L. M.Sc. Scientist. Taxonomy of Geraniaceae, Crassulaceae, Oxalidaceae
 Fish, Mrs L. B.Sc. Chief Scientific Officer. Taxonomy of Poaceae. Plant collecting programme; supervising mounters
 Glen, H.F. Ph.D. Senior Scientist. Taxonomy of trees and succulents, especially *Aloe*, herbarium for cultivated plants, and botanical collectors
 Glen, Mrs R.P. M.Sc. Senior Scientific Officer. Taxonomy of ferns, water plants
 Hoare (née Victor), Mrs J.E. B.Sc.(Hons.), H.Dip.Journ. Scientific Officer. Taxonomy of Rutaceae, Asclepiadaceae
 Jordaan, Mrs M. M.Sc. Chief Scientific Officer. Taxonomy of Casuarinaceae—Connaraceae, *Maytenus*

Kgaditsi, W.T. Specialized Auxiliary Services Officer I. Mounter, general assistant in cultivated plants section
 Lephaka, G.M. Specialized Auxiliary Services Officer I. Parcelling, pressing and general assistance
 Makgaka, K.S. Specialized Auxiliary Services Officer I. Mounter of vascular plants
 Makgaka, M.C. Senior Specialized Auxiliary Services Officer. Herbarium assistant, Wing B
 Makwarela, A.M. B.Sc. Scientific Officer
 Marinus, Mrs E. Principal Specialized Auxiliary Services Officer. Herbarium assistant
 Masombuka, Ms A.S. Specialized Auxiliary Services Officer I. Herbarium assistant
 Meyer, J.J. N.D.(Teaching). Scientific Officer. Herbarium assistant, Wing C
 Netnou, Ms N.C. B.Sc. Scientific Officer
 Nkoana, L.S. Scientific Officer (contract worker)
 Perold, Mrs S.M. Ph.D. Taxonomy of Ricciaceae, Hepaticae (contract worker)
 Phahla, T.J. Specialized Auxiliary Services Officer I. Mounter of bryophytes and vascular plants
 Ready, Mrs J.A. N.D.(Hort.). Senior Specialized Auxiliary Services Officer. Herbarium assistant, Wing D

Retief, Miss E. M.Sc. Senior Scientist. Pollen studies of Boraginaceae. Taxonomy of Boraginaceae, Verbenaceae, Lamiaceae, Asteraceae, Rubiaceae
 Riddles, L.M.D. B.Sc. Scientific Officer
 Schutte-Vlok, Mrs A.L. Ph.d. Scientist (contract worker)
 Sebothoma, P.N. Specialized Auxiliary Services Officer I. Herbarium assistant
 Smithies, Mrs S.J. M.Sc., Dip. Ed.(Moray House). Senior Scientific Officer. Taxonomy of Scrophulariaceae, Selaginaceae, Lobeliaceae

Steyn, Ms C.C. Principal Auxiliary Services Officer. Anatomy, palynology
 Van Rooy, J. M.Sc. Senior Scientist. Taxonomy and biogeography of mosses; supervising bryophyte mounters
 Veldman, Mrs J.M. Senior Provisioning Clerk. Herbarium administration
 Welman, Miss W.G. M.Sc. Senior Scientist. Taxonomy of Convolvulaceae, Solanaceae, Cucurbitaceae, Campanulaceae, Asteraceae, Acanthaceae

DATA MANAGEMENT—PRETORIA

Arnold, T.H. M.Sc. Assistant Director. Computer application especially in taxonomy

Botha, Mrs A.G. Principal Specialized Auxiliary Services Officer. Secretary
 De Wet, Mrs B.C. B.Sc.(Computer Science), B.A., H.D.L.S. Principal Datametrician
 Enslin, M. Student
 Evenwel, Mrs E. Specialized Auxiliary Services Officer. Quality control (contract worker)
 Harris, Mrs B.J. Specialized Auxiliary Services Officer.

Encoding, quality control
 Hawker, Mrs L.C. (contract worker)
 Joubert, Mrs M.A.E. Senior Data Typist
 Mbedzi, M.D. Specialized Auxiliary Services Officer II
 Prentice, Ms C. Scientist (contract worker)
 Snyman, Mrs E.E. N.D.(Comp. Data Proc.) Scientific Officer

EDUCATION AND RESEARCH SUPPORT—PRETORIA

Wolfson, Mrs M.M. Ph.D. Deputy Director. Physiology/Ecophysiology of Poaceae, carbon uptake metabolism, allocation in response to environmental and management stress

Clapperton, Mrs S. Typist II
 Du Plessis, Mrs. H. Head: Research Support Services & Publications
 Liebenberg, Mrs E.J.L. Head: Administration
 Potgieter, Mrs. E. Senior Librarian

EDUCATION

GOLD FIELDS CENTRE—CAPE TOWN

Ashwell, Ms A.N. M.Ed. B.Sc.
 Boonzaaier, I. Groundsman II
 Constable, M.D. Bus Driver
 Cupido, Ms M. Administrative Assistant I. Co-ordinator
 Hitchcock, Mrs W.A. Principal Communications Officer. Adult education
 Huët, Mrs H. Senior Administration Clerk
 Mkefe, T.J. SPTD, Communications Officer
 Tyokolo, Ms S.E. SPTD, Communications Officer (contract worker)

FREE STATE

Masilo, T. Scientific Officer

PRETORIA

Symonds, Ms A.M. N.D.(Nature Cons.), H.D.E. Principal Communications Officer

WITWATERSRAND

Van der Westhuizen, Mrs S. M.Sc. Principal Communications Officer
 Vlok, Mrs S. B.Com. Administrative Assistant

INTERPRETATION—PRETORIA

Joffe, Mrs H. B.Sc. Garden Utilization Officer

RESEARCH SUPPORT SERVICES AND PUBLICATIONS—PRETORIA

Du Plessis, Mrs H. M.Sc. Senior Scientist. Cytogenetics

Brink, Mrs S.S. Dip.(Typing). Chief Typesetter. Typesetting, layout, word processing
 Condy, Ms G.S. M.A. Senior Industrial Technician. Botanical artist
 Du Plessis, Mrs E. B.Sc.(Hons.), S.E.D. Technical editor. Editing, translating, layout
 Leistner, O.A. D.Sc., F.L.S. Editing (contract worker)

Mapheza, T.P. Senior Storeman II. Bookshop
 Momberg, Mrs B.A. B.Sc.(Entomology & Zoology). Technical editor. Editing, layout
 Maree, Ms D.J. Senior Typist
 Romanowski, Mrs A.J. Dip.(Photography). Senior Industrial Technician (Photography). Scientific photographer

MARY GUNN LIBRARY—PRETORIA

Potgieter, Mrs E. B. Libr.. Senior Librarian

Fourie, Mrs A. B. Libr. Assistant Librarian (contract worker)
 Shabangu, B.M. Student

ADMINISTRATION—PRETORIA

Liebenberg, Mrs E.J.L. M.Sc. Chief Scientific Officer. Cytotaxonomy. Manager

Götzel, Mrs A. Senior Telecom. Operator I
 Kama, Mrs P.B. Administration Aid I
 Khumalo, N.P. Principal General Foreman. Supervisor: Office services
 Koehne, Mrs R.W.R. Senior Registration Clerk
 Makgobola, Mrs M.R. Administration Aid I
 Malefo, R.P. Administration Aid I
 Maphuta, Mrs M.S. Administration Aid I

Martin, Ms M.A. Senior Administration Clerk I
 Nkosi, Mrs M.P. Administration Aid I
 Phaala, M.C. Administration Aid I
 Smuts, Mrs W.E. Administration Officer. Personnel
 Tloubatla, J.M. Courier/Photocopy Machine Operator
 Venter, W.A. N.T.C.II. Senior General Foreman. Maintenance

ECOLOGY AND CONSERVATION SUBDIRECTORATE

CAPE TOWN

Rutherford, M.C. Ph.D., Dip.(Datamet.). Deputy Director

Davis, G.W. Ph.D. Assistant Director. Head: Ecology liaison. Stress and disturbance ecology
 Nänni, Ms I. B.Sc., H.D.E. Head: Research Support Services
 Reynolds, Ms P.Y. B.A., H.D.L.S., B.Proc. Senior Librarian

Bösenberg, J. de Wet B.Sc.(Hons.). Principal Scientific Officer. Cycad biology and conservation
 Botha, P.A. N.H.D.(Hort.). Senior Scientific Officer. Tissue culture research, seed biology
 Brown, N.A.C. Ph.D. Specialist Scientist. Seed biology research, plant growth regulators
 De Lange, J.H. B.Sc.(Hort.), M.Sc.(Plant Physiology), D.Sc.(Agric.), Ph.D.(Bot.). Senior Specialist Scientist. Ecology, tissue culture, horticulture
 Donaldson, J.S. M.Sc.(Entomology), Ph.D.(Zoology). Assistant Director. Cycad biology, plant/insect interactions, conservatio biology

Hilton-Taylor, C. B.SC.(Hons.)(Biol. Sci.). Scientist. Threatened plants, biodiversity of arid regions
 Hoffman, M.T. Ph.D. Principal Scientist. Disturbance and historical ecology
 Hunter, Ms D.A. Senior Administration Clerk I. Secretary
 Jacobs, E.C. Specialized Auxiliary Services Officer I. Laboratory Assistant. *Cyclopia*/Honeybush tea project
 Joubert, E.L. Scientist
 McDonald, D.J. Ph.D. Principal Scientist. Mountain vegetation, biogeography, conservation
 Midgley, G.F. M.Sc. Principal Scientist. Plant stress physiology/ecology

Mjwara, J.M. Senior Scientist
 Musil, C.F. Ph.D. Specialist Scientist. Plant stress physiology/ecology
 O'Callaghan, M.G. Ph.D. Principal Scientist. Plant climate interactions
 Petersen, Ms A. M.Sc. Scientific Officer. Disturbance and historical ecology (contract worker)

Pieper-Höweling, Ms H. GIS Operator (contract worker)
 Powrie, L.W. M.Sc. Chief Scientific Officer. Ecological databases: computer co-ordination
 Rebelo, A.G. Ph.D.(Zoology). Senior Scientist. Conservation biology, biogeography
 Wand, Ms S.J.E. M.Sc.(Agric.). Scientist. Plant stress physiology/ecology

RESEARCH SUPPORT SERVICES—CAPE TOWN

Nänni, Ms I. B.Sc., H.D.E. Chief Scientific Officer. Manager

Arnolds, Ms J.L. Laboratory Assistant
 Bowler, Mrs M. Laboratory & Office Aid II
 De Witt, D.M. Principal Specialized Auxiliary Services Officer. Scientific Assistant
 Jagger, B.W. Principal Specialized Auxiliary Services Officer. Scientific Assistant

Madikane, Ms B.R. Specialized Auxiliary Services Officer II. Communication Assistant
 Parenzee, Ms H.A. Dip. Ed. Senior Administration Clerk I
 Snyders, S.G. Specialized Auxiliary Services Officer I. General Assistant

HARRY MOLTEÑO LIBRARY—CAPE TOWN

Reynolds, Ms P.Y. B.A., H.D.L.S., B.Proc., B. Bibl.(Hons.). Senior Librarian

Edwards, Mrs J. A.L.A.(UK). Cataloguer (contract worker)
 Maqetuka, Ms N. Student (contract worker)
 Ramphele, Ms M.C. Student

PUBLICATIONS BY THE STAFF

1 April 1996–31 March 1997

- ANDERSON, J.M. 1996. Review: Fossil floras of China through the geological ages. *IOP Newsletter* 57, April 1996: 7, 8.
- ANDERSON, J., ANDERSON, H., FAITI, P. & SICHEL, H. 1996. The Triassic explosion(?): a statistical model for extrapolating biodiversity based on the terrestrial Molteno Formation. *Paleobiology* 22: 318–328.
- ASHWELL, A.N. 1997. Growing people for green environments: the NBI's environmental education programme takes root. *Veld & Flora* 83: 10–14.
- ARCHER, C. & ARCHER, R.H. 1996. A new species of *Holothrix* Lindl. (Orchidaceae) from northern KwaZulu-Natal. *South African Journal of Botany* 62: 209–211.
- ARCHER, R.H. & ARCHER, C. 1996. Should *Crinum forbesii* (Lindl.) Schult. & Schult.f. be reinstated? (Amaryllidaceae) *Bothalia* 26: 153.
- ARCHER, R.H. & VAN WYK, A.E. 1996a. Correct orthography and author citation for *Elaeodendron* (Celastraceae). *Bothalia* 26: 41, 42.
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- WILLIS, C.K. (ed.) 1996b. *SABONET News* 1,2. Newsletter of the Southern African Botanical Diversity Network. National Botanical Institute, Pretoria.

Guide for authors to *Bothalia*

This guide is updated when necessary and includes an index. **Important points and latest additions appear in bold type.**

Bothalia is named in honour of General Louis Botha, first Premier and Minister of Agriculture of the Union of South Africa. This house journal of the National Botanical Institute, Pretoria, is devoted to the furtherance of botanical science. The main fields covered are taxonomy, ecology, anatomy and cytology. Two parts of the journal and an index to contents, authors and subjects are published annually.

1 Editorial policy

1.1 *Bothalia* welcomes original papers dealing with flora and vegetation of southern Africa and related subjects. Full-length papers and short notes, as well as book reviews, are accepted.

1.2 **Page charges:** As stated in our notification included in volume 23,1 (May 1993), MSS submitted for publication in *Bothalia* are subject to payment of page charges of R125.00 per printed page, VAT included. The following are exempt from these charges: 1, NBI members; 2, persons/institutions who have been granted exemption by the Executive Committee of the NBI; 3, authors of contributions requested by the Editor; 4, contributors to the column 'FSA contributions'. The Editor's decision on the number of pages is final. An invoice will be sent to the author, who must arrange for payment as soon as possible to NBI, Publications Section, Private Bag X101, Pretoria 0001.

1.3 Articles are assessed by referees, both local and overseas. Authors are welcome to suggest possible referees to judge their work. Authors are responsible for the factual correctness of their contributions. *Bothalia* maintains an editorial board (see title page) to ensure that international standards are upheld.

2 Requirements for a manuscript

2.1 The original manuscript should be typed on one side of A4-size paper, double-spaced throughout (including abstract, tables, captions to figures, literature references, etc.) and have a margin of at least 30 mm all round. **Three photocopies (photocopied on both sides of the paper to reduce weight for postage)** of all items, including text, illustrations, tables and lists should be submitted, and the author should retain a complete set of copies. If the article was generated on a computer, a copy of the diskette should be submitted with the final (accepted) version (see 3).

2.2 Papers should conform to the general style and layout of recent issues of *Bothalia* (from volume 26 onwards).

2.3 Material should be presented in the following sequence: Title page with title, name(s) of author(s), key-words, abstract (and information that should be placed in a footnote on the title page, such as address(es) of author(s) and mention of granting agencies.

2.4 The sequence continues with Introduction and aims, Material and methods, Results, Interpretation (Discussion), Specimens examined (in revisions and monographs), Acknowledgements, References, Index of names (recommended for revisions dealing with more than about 15 species), Tables, Captions for figures and figures. In the case of short notes and book reviews, key-words and abstract are superfluous.

2.5 All pages must be numbered consecutively beginning with the title page to those with references, tables and captions for figures.

2.6 For notes on the use of hyphens and dashes see 3.10 to 3.12.

2.7 Special character: use your own word or code that is unique and self-explanatory, enclosed between ANGLE BRACKETS, e.g. <mu>m for µm. Please supply us with a list of the codes.

3 Requirements for diskettes/stiffies

(to be submitted only with final/accepted version)

3.1 data must be IBM compatible and written in **ASCII, or in Word for Windows from Windows 1; Word for MS-DOS from MSWord 3; WordPerfect 5 for DOS only; Windows Write 3 onwards.**

3.2 the original printout of the diskette should be supplied in **double line** spacing.

3.3 tables need not be placed on the diskette—a clearly laid out hard copy is adequate.

3.4 use a **non-breaking space** to keep two elements together on the same line, e.g. 3 500.

3.5 do not justify lines.

3.6 do not break words, except hyphenated words.

3.7 all lines, headings, keys, etc., should start flush at the margin, therefore **no indentations, footnotes or tabs** of any kind.

3.8 in **Word and WordPerfect**, italics and bold should be used where necessary.

3.9 paragraphs and headings are delineated by a carriage return (ENTER) but **no indentation.**

3.10 a hyphen is designated as one dash, with no space between the letter and the dash, e.g. ovate-lanceolate. See also 17.6.

3.11 an N-dash is typed as **three** hyphens with no space between the letter and the hyphen, e.g. 2- -5 mm (typeset, it looks like this, 2–5 mm).

3.12 an M-dash is typed as **two** hyphens with no space between the letter and the hyphen, e.g. computers- -what a blessing! (typeset, it looks like this: computers—what).

3.13 do not use a double space between words, after commas, full stops, colons, semicolons or exclamation marks.

3.14 use lower case x as times sign, with one space on either side of the x, e.g. 2 x 3 mm.

3.15 use **single (not double)** opening and closing quotes, e.g. the so-called 'stiffy' refers to a rigid diskette.

3.16 keys—put only three leader dots before number of taxon (with one space before and one space after the first and last dot), regardless of how far or near the word is from the right margin. e.g. ... 1. *R. ovata* (see 13.18).

4 Author(s)

When there are several authors the covering letter should indicate clearly which of them is responsible for correspondence and, if possible, telephonically available while the article is being processed. The contact address and telephone number should be mentioned if they differ from those given on the letterhead.

5 Title

The title should be as concise and as informative as possible. In articles dealing with taxonomy or closely related subjects the family of the taxon under discussion (see also 13.2) should be mentioned in brackets but **author citations should be omitted from plant names** (see also 13.6).

6 Keywords

Up to 10 keywords (or index terms) should be provided in English in **alphabetical sequence**. The following points should be borne in mind when selecting keywords:

6.1 keywords should be unambiguous, internationally acceptable words and not recently coined little-known words.

6.2 they should be in a noun form and verbs should be avoided.

6.3 they should not consist of an adjective alone; adjectives should be combined with nouns.

6.4 they should not contain prepositions.

6.5 the singular form should be used for processes and properties, e.g. cvaporation.

6.6 the plural form should be used for physical objects, e.g. augers.

6.7 location (province and/or country); taxa (species, genus, family) and vegetation type (community, veld type, biome) should be used as keywords.

6.8 keywords should be selected hierarchically where possible, e.g. both family and species should be included.

6.9 they should include terms used in the title.

6.10 they should answer the following questions:

6.10.1 what is the *active concept* in the document (activity, operation or process).

6.10.2 what is the *passive concept* or object of the active process (item on which the activity, operation or process takes place).

6.10.3 what is the means of accomplishment or how is the active concept achieved (technique, method, apparatus, operation or process).

6.10.4 what is the environment in which the active concept takes place (medium, location).

6.10.5 what are the independent (controlled) and dependent variables?

6.11 questions 6.10.1 to 6.10.3 should preferably also be answered in the title.

7 Abstract

7.1 Abstracts of no more than 200 words should be provided. Abstracts are of great importance and should convey the essence of the article.

7.2 They should refer to the geographical area concerned and, in taxonomic articles, mention the number of taxa treated. They should not contain information not appearing in the article.

7.3 In articles dealing with taxonomy or closely related subjects all taxa from the rank of genus downwards should be accompanied by their author citations (see also 13.6).

7.4 Names of new taxa and new combinations should not be italicized. If the article deals with too many taxa, only the important ones should be mentioned.

8 Table of contents

A table of contents should be given for all articles longer than about 40 typed pages, unless they follow the strict format of a taxonomic revision.

9 Acknowledgements

Acknowledgements should be kept to the minimum compatible with the requirements of courtesy. Please give all the initials of the person(s) you are thanking.

10 Literature references

In text

10.1 Literature references in the text should be cited as follows: 'Jones & Smith (1986) stated...', or '...(Jones & Smith 1986)' or (Ellis 1988: 67) when giving a reference simply as authority for a statement. For treatment of literature references in taxonomic papers see 14.

10.2 When **more than two authors** are involved in the paper, use the name of the first author followed by *et al.*

10.3 When referring to more than one literature reference, they should be arranged **chronologically** and separated by a semicolon, e.g. (Nixon 1940; Davis 1976; Anon. 1981, 1984).

10.4 Titles of books and names of journals should preferably not be mentioned in the text. If there is good reason for doing so, they should be treated as described in 10.12 & 10.13.

10.5 Personal communications are given only in the text, not in the list of references. Please add the person's full initials to identify the person more positively, e.g. C. Boucher pers. comm.

In References at end of article

10.6 References of the same author are arranged in chronological sequence.

10.7 Where two or more references by the same author are listed in succession, the author's name is repeated with every reference, except in an obituary, where the name of the deceased in the list of publications (not in the references) is replaced by an N-dash.

10.8 All publications referred to in the text, including those mentioned in full in the treatment of correct names in taxonomic papers, but no others, and no personal communications, are listed at the end of the manuscript under the heading References.

10.9 The references are arranged alphabetically according to authors and chronologically under each author, with a, b, c, etc. added to the year, if the author has published more than one work in a year. **This sequence is retained when used in the text, irrespective of the chronology.**

10.10 If an author has published both on his own and as a senior author with others, the solo publications are listed first and after that, in strict alphabetical sequence, those published with one or more other authors.

10.11 Author names are typed in capitals.

10.12 Titles of journals and of books are written out in full and are italicized as follows: *Transactions of the Linnean Society of London* 5: 171–217, or *Biology and ecology of weeds*: 24.

10.13 Titles of books should be given as in *Taxonomic literature*, edn 2 by Stafleu & Cowan and names of journals as in the latest edition of *World list of scientific periodicals*.

10.14 Examples of references:

Collective book or Flora

BROWN, N.E. 1909. Asclepiadaceae. In W.T. Thiselton-Dyer, *Flora capensis* 6.2: 518–1036. Reeve, London.

CUNNINGHAM, A.B. 1994. Combining skills: participatory approaches in biodiversity conservation. In B.J. Huntley, *Botanical diversity in southern Africa*. *Strelitzia* 1: 149–167. National Botanical Institute, Pretoria.

Book

DU TOIT, A.L. 1966. *Geology of South Africa*, 3rd edn, S.M. Haughton (ed.). Oliver & Boyd, London.

HUTCHINSON, J. 1946. *A botanist in southern Africa*. Gawthorn, London.

Journal

DAVIS, G. 1988. Description of a proteoid-restioid stand in Mesic Mountain Fynbos of the southwestern Cape and some aspects of its ecology. *Bothalia* 18: 279–287.

SMOOK, L. & GIBBS RUSSELL, G.E. 1985. Poaceae. *Memoirs of the Botanical Survey of South Africa* No. 51: 45–70.

STEBBINS, G.L. Jr 1952. Aridity as a stimulus to plant evolution. *American Naturalist* 86: 35–44.

In press, in preparation

TAYLOR, H.C. in press. *A reconnaissance of the vegetation of Rooiberg State Forest*. Technical Bulletin, Department of Forestry.

VOGEL, J.C. 1982. *The age of the the Kuiseb river silt terrace at Homeb*. *Palaeoecology of Africa* 15. In press.

WEISSER, P.J., GARLAND, J.F. & DREWS, B.K. in prep. Dune advancement 1937–1977 and preliminary vegetation succession chronology at Mlalazi Nature Reserve, Natal, South Africa. *Bothalia*.

Thesis

KRUGER, F.J. 1974. *The physiography and plant communities of the Jakkalsrivier Catchment*. M.Sc. (Forestry) thesis, University of Stellenbosch.

MUNDAY, J. 1980. *The genus Monechma Hochst. (Acanthaceae tribe Justicieae) in southern Africa*. M.Sc. thesis, University of the Witwatersrand, Johannesburg.

Miscellaneous paper, report, unpublished article, technical note, congress proceedings

ANON. no date. *Eetbare plante van die Wolkberg*. Botanical Research Unit, Grahamstown. Unpublished.

BAWDEN, M.G. & CARROL, D.M. 1968. *The land resources of Lesotho*. Land Resources Study No. 3, Land Resources Division, Directorate of Overseas Surveys, Tolworth.

BOUCHER, C. 1981. Contributions of the Botanical Research Institute. In A.E.F. Heydon, *Proceedings of workshop research in Cape estuaries*: 105–107. National Research Institute for Oceanology, CSIR, Stellenbosch.

NATIONAL BUILDING RESEARCH INSTITUTE 1959. *Report of the committee on the protection of building timbers in South Africa against termites, woodboring beetles and fungi*, 2nd edn. CSIR Research Report No. 169.

11 Tables

11.1 Each table should be presented on a separate sheet and be assigned an Arabic numeral, i.e. the first table mentioned in the text is marked 'Table 1'.

11.2 In the captions of tables the word 'TABLE' is written in capital letters. See recent numbers of *Bothalia* for the format required.

11.3 Avoid vertical lines, if at all possible. Tables can often be reduced in width by interchanging primary horizontal and vertical heads.

12 Figures

12.1 Figures should be planned to fit, after reduction, into a width of either 80, 118 or 165 mm, with a maximum vertical length of 230 mm. Allow space for the caption in the case of figures that will occupy a whole page.

12.2 Line drawings, including graphs and diagrams, should be twice the size of the final reproduction and should be in jet-black Indian ink, preferably on fine Felix Schoeller parole or similar paper, 200 gsm, or tracing film. Lines should be bold enough and **letters/symbols large enough** to stand reduction.

12.3 Photographs should be of excellent quality on glossy paper with clear detail and moderate contrast, and they should be the same size as required in the journal.

12.4 Photograph mosaics should be submitted complete, the component photographs mounted neatly on a white **flexible card base (can be curved around drum of scanner)** leaving a narrow gap of uniform width (2 mm) between each print. Note that grouping photographs of markedly divergent contrast results in poor reproductions.

12.5 Lettering and numbering on all figures should be done in lettraset, stencilling or a comparable method. If symbols are to be placed on a dark background it is recommended that black symbols are used on a small white disk ± 7 mm in diameter and placed in the **lower left hand corner** of the relevant photo.

12.6 If several illustrations are treated as components of a single composite figure they should be designated by **capital letters**.

12.7 Note that the word 'Figure' should be written out in full, both in the text and the captions and should begin with a capital 'F' (**but see 14.7 for taxonomic papers**).

12.8 In the text the figure reference is then written as in the following example: 'The stamens (Figure 4A, B, C) are...'

12.9 In captions, 'FIGURE' is written in capital letters. Magnification of figures should be given for the size as submitted.

12.10 **Scale bars or scale lines should be used on figures.**

12.11 In figures accompanying taxonomic papers, voucher specimens should be given in the relevant caption.

12.12 Figures are numbered consecutively with Arabic numerals **in the order they are referred to in the text**. These numbers, as well as the author's name and an indication of the top of the figure, must be written in soft pencil on the back of all figures.

12.13 Captions of figures must **not** be pasted under the photograph or drawing.

12.14 Authors should indicate **in pencil** in the text where they would like the figures to appear.

12.15 Authors wishing to have the originals of figures returned must inform the editor in the original covering letter and must mark each original 'To be returned to author'.

12.16 Authors wishing to use illustrations already published must obtain written permission before submitting the manuscript and inform the editor of this fact.

12.17 Captions for figures should be collected together and typed **at the end of the MS** and headed *Captions for figures*.

12.18 It is strongly recommended that taxonomic articles include dot maps as figures to show the distribution of taxa. The dots used must be large enough to stand reduction to 80 mm (recommended size: letaset 5 mm diameter). **No open diamonds or open triangles should be used.**

12.19 Blank distribution maps of southern Africa, Africa and the world are available from the Bookshop, NBI Pretoria.

13 Text

13.1 As a rule, authors should use the names (but not of all authors of plant names—see 13.6) as listed by T.H. Arnold & B.C. de Wet (eds) in *Memoirs of the Botanical Survey of South Africa* No. 62.

13.2 Names of genera and infrageneric taxa are usually italicized, with the author citation (where relevant; see 13.6) not italicized. Exceptions include names of new taxa in the abstract, correct names given in the synopsis or in paragraphs on species excluded from a given supraspecific group in taxonomic articles; in checklists and in indices, where the position is reversed, correct names are not italicized and synonyms are italicized.

13.3 Names above generic level are not italicized.

13.4 In articles dealing with taxonomy, the complete scientific name of a plant (with author citation) should be given at the first mention in the text. The generic name should be abbreviated to the initial thereafter, except where intervening references to other genera with the same initial could cause confusion (see 16.6).

13.5 **In normal text, Latin words are italicized, but in the synopsis of a species, Latin words such as *nom. nud.* and *et al.* are not italicized** (see 14.3, 16.4, 17.9).

13.6 In accordance with Garnock-Jones & Webb (1996) in *Taxon* 45: 285, 286, authors of plant names are not to be added to plant names except in taxonomic papers. Names of authors of plant names should agree with the list published by the Royal Botanic Gardens, Kew, entitled, *Authors of plant names*, edited by R.K. Brummitt & C.E. Powell (1992).

13.7 Modern authors not included in the list should use their full name and initials when publishing new plant names. Other author names not in the list should be in agreement with the recommendations of the Code.

13.8 Names of authors of publications are written out in full except in the synonymy in taxonomic articles where they are treated like names of authors of plant names.

13.9 Names of plant collectors are italicized whenever they are linked to the number of a specimen. The collection number is also italicized, e.g. *Acocks 14407*.

13.10 Surnames beginning with 'De', 'Du' or 'Van' begin with a capital letter unless preceded by an initial.

13.11 For measurements use only units of the International System of Units (SI). **In taxonomic papers only mm and m, should be used; in ecological papers cm or m should be used.**

13.12 The use of '±' is preferred to c. or ca (see 17.7).

13.13 Numbers 'one' to 'nine' are spelled out in normal text, and from 10 onwards they are written in Arabic numerals.

13.14 In descriptions of plants, numerals are used throughout. Write 2.0–4.5 (not 2–4.5). When counting members write 2 or 3 (not 2–3), but 2–4.

13.15 Abbreviations should be used sparingly but consistently. No full stops are placed after abbreviations ending with the last letter of the full word (e.g. edition = edn; editor = ed.); after units of measure; after compass directions; after herbarium designations; **after countries, e.g. USA and after well-known institutions, e.g. CSIR.**

13.16 Apart from multi-access keys, indented keys should be used with couplets numbered 1a–1b, 2a–2b, etc. (without full stops thereafter).

13.17 Keys consisting of a single couplet have no numbering.

13.18 Manuscripts of keys should be presented as in the following example:

1a Leaves closely arranged on an elongated stem; a submerged aquatic with only the capitula exserted ... 1b. *E. setaceum* var. *pumilum*

1b Leaves in basal rosettes; stems suppressed; small marsh plants, ruderals or rarely aquatics:

2a Annuals, small, fast-growing pioneers, dying when the habitat dries up; capitula without coarse white setae; receptacles cylindrical:

3a Anthers white ... 2. *E. cinereum*

3b Anthers black ... 3. *E. nigrum*

2b Perennials, more robust plants; capitula sparsely to densely covered with short setae:

13.19 Herbarium voucher specimens should be referred to wherever possible, not only in taxonomic articles.

14 Species treatment in taxonomic papers

14.1 The procedure to be followed is illustrated in the example (17.9), which should be referred to, because not all steps are described in full detail.

14.2 The correct name (not italicized) is to be followed by its author citation (italicized) and the full literature reference, with the name of the publication written out in full (not italicized).

14.3 Thereafter all literature references, including those of the synonyms, should only reflect author, page and year of publication, e.g. C.E. Hubb. in Kew Bulletin 15: 307 (1960); Boris et al.: 14 (1966); Boris: 89 (1967); Sims: t. 38 (1977); Sims: 67 (1980).

14.4 The description and the discussion should consist of paragraphs commencing, where possible, with italicized leader words such as *flowering time*, *etymology*, *diagnostic characters*, *distribution* and *habitat*.

14.5 When more than one species of a given genus is dealt with in a paper, the correct name of each species should be prefixed by a sequential number followed by a full stop. Intraspecific taxa are marked with small letters, e.g. Ib., 12c., etc.

14.6 Names of authors are written as in 13.6, irrespective of whether the person in question is cited as the author of a plant name or of a publication.

14.7 The word 'figure' is written as 'fig.', and 't.' is used for both 'plate' and 'tablet' (but see 12.7 for normal text).

14.8 Literature references providing good illustrations of the species in question may be cited in a paragraph commencing with the word *Icones* followed by a colon. This paragraph is given after the last paragraph of the synonymy, see 17.9.

15 Citation of specimens

15.1 Type specimen in synopsis: the following should be given (if available): country (if not in RSA), province, grid reference (at least for new taxa), locality as given by original collector, modern equivalent of collecting locality in square brackets (if relevant, e.g. Port Natal [now Durban]), **quarter-degree square**, date of collection (optional), collector's name and collecting number (both italicized).

15.2 The abbreviation *s.n.* (*sine numero*) is given after the name of a collector who usually assigned numbers to his collections but did not do so in the specimen in question. The herbaria in which the relevant type(s) are housed are indicated by means of the abbreviations given in the latest edition of *Index Herbariorum*.

15.3 The holotype (holo.) and its location are mentioned first, followed by a semicolon, the other herbaria are arranged alphabetically, separated by commas.

15.4 Authors should indicate by means of an exclamation mark (!) which of the types have been personally examined.

15.5 If only a photograph or microfiche was seen, write as follows: *Anon.* 422 (X, holo.—BOL, photo!).

15.6 Lectotypes or neotypes should be chosen for correct names without a holotype. It is not necessary to lectotypify synonyms.

15.7 When a lectotype or a neotype are newly chosen, this should be indicated by using the phrase 'here designated' (see 17.9). If reference is made to a previously selected lectotype or neotype, the name of the designating author and the literature reference should be given. In cases where no type was cited, and none has subsequently been nominated, this may be stated as 'not designated'.

15.8 In brief papers mentioning only a few species and a few cited specimens the specimens should be arranged according to the grid reference system: Provinces/countries (typed in capitals) should be cited in the following order: Namibia, Botswana, Northern Province (previously Northern Transvaal), North-West (previously northeastern Cape and southwestern Transvaal), Gauteng (previously PWV), Mpumalanga (previously Eastern Transvaal), Free State (previously Orange Free State), Swaziland, KwaZulu-Natal (previously Natal), Lesotho, and Northern Cape, Western Cape and Eastern Cape (Figure 1).

15.9 Grid references should be cited in numerical sequence.

15.10 Locality records for specimens should preferably be given to within a quarter-degree square. Records from the same one-degree square are given in alphabetical order, i.e. (—AC) precedes (—AD), etc. Records from the same quarter-degree square are arranged alphabetically according to the collectors' names; the quarter-degree references must be repeated for each specimen cited.

15.11 The relevant international code of the herbaria in which a collection was seen should be given in brackets after the collection number; the codes are separated by commas. The following example will explain the procedure:

KWAZULU-NATAL.—2731 (Louwsburg): 16 km E of Nongoma. (—DD). *Pelser* 354 (BM, K, PRE); near Dwaarsrand, *Van der Merwe* 4789 (BOL, M). 2829 (Harrismith): near Groothoek. (—AB), *Smith* 234; Koffiefontein. (—AB), *Taylor* 720 (PRE); Cathedral Peak Forest Station. (—CC), *Marriot* 74 (KMG); Wilgerfontein, *Roux* 426. Grid ref. unknown: Sterkstroom, *Strydom* 12 (NBG).

15.12 For records from outside southern Africa authors should use degree squares without names, e.g.:

KENYA.—0136: Nairobi plains beyond race course, *Napier* 485.

15.13 Monographs and revisions: in the case of all major works of this nature it is assumed that the author has investigated the relevant material in all major herbaria and that he has provided the specimens seen with determinavit labels. It is assumed further that the author has submitted distribution maps for all relevant taxa and that the distribution has been described briefly in words in the text. Under the heading 'Vouchers' no more than five specimens should be cited, indicating merely the collector and the collector's number (both italicized). Specimens are alphabetically arranged according to collector's name. If more than one specimen by the same collector is cited, they are arranged numerically and separated by a comma. The purpose of the cited specimens is not to indicate distribution but to convey the author's concept of the taxon in question.

15.14 The herbaria in which the specimens are housed are indicated by means of the abbreviation given in the

latest edition of *Index Herbariorum*. They are given between brackets, arranged alphabetically and separated by commas behind every specimen as in the following example:

Vouchers: *Arnold* 64 (PRE); *Fisher* 840 (NH, NU, PRE); *Flanagan* 831 (GRA, PRE), 840 (NH, PRE); *Marloth* 4926 (PRE, STE); *Schelppe* 6161, 6163, 6405 (BOL); *Schlechter* 4451 (BM, BOL, GRA, K, PRE).

15.15 If long lists of specimens are given, they must be listed together before Acknowledgements under the heading *Specimens examined*. They are arranged alphabetically by the collector's name and then numerically for each collector. The species is indicated in brackets by the number that was assigned to it in the text and any infraspecific taxa by a small letter. If more than one genus is dealt with in a given article, the first species of the first genus mentioned is indicated as 1.1. This is followed by the international herbarium designation. Note that the name of the collector and the collection number are italicized:

Acocks 12497 (2.1b) BM, K, PRE; 14724 (1.13a) BOL, K, P. *Archer* 1507 (1.4) BM, G. *Burchell* 2847 (2.8c) MB, K. *Burnan* 2401 (3.3) MO, S. B.L. *Burt* 789 (2.6) B, KMG, STE.

16 Synonyms

16.1 In a monograph or a revision covering all of southern Africa, all synonyms based on types of southern African origin, or used in southern African literature, should be included.

16.2 Illegitimate names are designated by *nom. illeg.* after the reference, followed by *non* with the author and date, if there is an earlier homonym.

16.3 *Nomina nuda* (*nom. nud.*) and invalidly published names are excluded unless there is a special reason to cite them, for example if they have been used in prominent publications.

16.4 In normal text Latin words are italicized, but in the synopsis of a species Latin words such as *nom. nud.*, *et al.* are not italicized (see 13.5, 14.3, 17.9).

16.5 Synonyms should be arranged chronologically into groups of nomenclatural synonyms, i.e. synonyms based on the same type, and the groups should be arranged chronologically by basionyms, except for the basionym of the correct name which is dealt with in the paragraph directly after that of the correct name.

16.6 When a generic name is repeated in a given synonymy it should be abbreviated to the initial, except where intervening references to other genera with the same initial could cause confusion (see 13.4).

17 Description and example of species treatment

17.1 Descriptions of all taxa of higher plants should, where possible, follow the sequence: Habit; sexuality; underground parts (if relevant). *Indumentum* (if it can be easily described for the whole plant). *Stems/branches*. *Bark*. *Leaves*: arrangement, petiole absent/present, pubescence; blade: shape, size, apex, base, margin; midrib: above/below, texture, colour; petiole; stipules. *Inflorescence*: type, shape, position; bracts/bracteoles. *Flowers*: shape, sex. *Receptacle*. *Calyx*. *Corolla*. *Disc*. *Androecium*. *Gynoecium*. *Fruit*. *Seeds*. *Chromosome number*. *Conservation status*. Figure (word written out in full) number.

17.2 As a rule, shape should be given before measurements.

17.3 In general, if an organ has more than one of the parts being described, use the plural, otherwise use the singular, for example, petals of a flower but blade of a leaf.

17.4 Language must be as concise as possible, using participles instead of verbs.

17.5 Dimension ranges should be cited as in 17.9.

17.6 Care must be exercised in the use of dashes and hyphens. A hyphen is a short stroke joining two syllables of a word, e.g. ovate-lanceolate or sea-green, with no space between the letter and the stroke. An *N-dash* (*en*) is a longer stroke commonly used instead of the word 'to' between numerals, '2–5 mm long' (do not use it between words but rather use the word 'to', e.g. 'ovate to lanceolate'; it is produced by typing three hyphens next to each other. An *M-dash* (*em*) is a stroke longer than an *N-dash* and is used variously, e.g. in front of a subspecific epithet instead of the full species name; it is produced by typing two hyphens next to one another.

17.7 The use of '±' is preferred to c. or ca when describing shape, measurements, dimensions, etc. (see 13.12).

17.8 The decimal point replaces the comma in all units of measurement, e.g. leaves 1.0–1.5 mm long.

17.9 Example:

1. *Englerophytum magalismontanum* (Sond.) T.D.Penn. The genera of Sapotaceae: 252 (1991). Type: Gauteng, Magaliesberg, Zeyher 1849 (S, holo.–BOL, photo!).

Bequaertiodendron magalismontanum (Sond.) Heine & Hemsl.: 307 (1960); Codd: 72 (1964); Elsdon: 75 (1980).

Chrysophyllum magalismontanum Sond.: 721 (1850); Harv.: 812 (1867); Engl.: 434 (1904); Bottmar: 34 (1919). *Zeyherella magalismontana* (Sond.) Aubrév. & Pellegr.: 105 (1958); Justin: 97 (1973).

Chrysophyllum argyrophyllum Hiern: 721 (1850); Engl.: 43 (1904). *Boivinella argyrophylla* (Hiern) Aubrév. & Pellegr.: 37 (1958); Justin: 98 (1973). Types: Angola, Welwitsch 4828 (BM!), lecto., here designated; PRE!; Angola, Welwitsch 4872 (BM!).

Chrysophyllum wilmsii Engl.: 4, t. 16 (1904); Masonet: 77 (1923); Woodson: 244 (1937). *Boivinella wilmsii* (Engl.) Aubrév. & Pellegr.: 39 (1958); Justin: 99 (1973). Type: Mpumalanga, Magoebaskloof, Wilms 1812 [B, holo.†; K!, P!, lecto., designated by Aubrév. & Pellegr.: 38 (1958), PRE!, S!, W!, Z!].

Bequaertiodendron fruticosum De Wild.: 37 (1923), non Bonpl.: 590 (1823); D.Bakker: 167 (1929); H.Fr.: 302 (1938); Davy: 640 (1954); Breytenbach: 117 (1959); Clausen: 720 (1968); Palmer: 34 (1969). Type: Mpumalanga, Tzaneen Dist., Graunville 3665 (K, holo.†; G!, P!, PRE!, S!).

B. fragrans auct. non Oldemann: Glover: 149, t. 19 (1915); Henkel: 226 (1934); Stapleton: 6 (1954).

Icones: Harv.: 812 (1867); Henkel: t. 84 (1934?); Codd: 73 (1964); Palmer: 35 (1969).

Woody perennial; main branches up to 0.4 m long, erect or decumbent, grey woolly-felted, leafy. *Leaves* linear to oblanceolate, 3–10(–23) × 1.0–1.5(–4.0) mm, obtuse, base broad, half-clasping. *Heads* heterogamous, campanulate, 7–8 × 5 mm, solitary, sessile at tip of axillary shoots; involucre bracts in 5 or 6 series, inner exceeding flowers, tips subopaque, white, very acute. *Receptacle* nearly smooth. *Flowers* ± 23–30, 7–11 male, 16–21 bisexual, yellow, tipped pink. *Achenes* ± 0.75 mm long, elliptic. *Pappus* bristles very many, equalling corolla, scabridulous. *Chromosome number*: 2n = 22. Figure 23B.

18 New taxa

18.1 The name of a new taxon must be accompanied by at least a Latin diagnosis. Authors should not provide full-length Latin descriptions unless they have the required expertise in Latin at their disposal.

18.2 It is recommended that descriptions of new taxa be accompanied by a good illustration (line drawing or photograph) and a distribution map.

18.3 Example:

109. *Helichrysium jubilatum* Hilliard, sp. nov. *H. alsinoidei* DC. affinis, sed foliis ellipticis (nec spatulatis), inflorescentiis compositis a foliis non circumcinctis, floribus femineis numero quasi dimidium hermaphroditorum aequantibus (nec capitulis homogamis vel floribus femineis 1–3 tantum) distinguitur.

Herba annua e basi ramosa; caules erecti vel decumbentes, 100–250 mm longi, tenuiter albo-lanati, remote foliati. *Folia* plerumque 8–30 × 5–15 mm, sub capitulis minora, elliptica vel oblanceolata, obtusa vel acuta, mucronata, basi semi-amplexicauli, utrinque cano-lanato-arachnoidea. *Capitula* heterogama, campanulata, 3.5–4.0 × 2.5 mm, pro parte maxima in paniculas cymosas terminales aggregata; capitula subterminalia interdum solitaria vel 2 vel 3 ad apices ramulorum nudorum ad 30 mm longorum. *Bractee involucales* 5-seriatae, gradatae, exteriores pellucidae, pallide stramineae, dorso lanatae, seriebus duabus interioribus subaequalibus et flores quasi aequantibus, apicibus obtusis opacis niveis vix radiantibus. *Receptaculum* fere laeve. *Flores* ± 35–41. *Achenia* 0.75 mm longa, pilis myxogenis praedita. *Pappi* setae multae, corollam aequantes, apicibus scabridis, basibus non cohaerentibus.

TYPE.—Northern Cape, 2817 (Vioolsdrif): Richtersveld, (–CC), ± 5 miles E of Lekkersing on road to Stinkfontein, kloof in hill south of road, annual, disc whitish, 7–11–1962, *Nordenstam* 1823 (S, holo.; E, NH, PRE).

19 New provinces of South Africa (Oct. 1996)

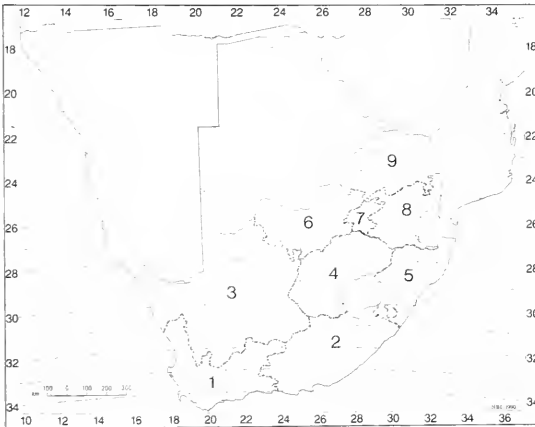


FIGURE 1.—1, Western Cape; 2, Eastern Cape; 3, Northern Cape; 4, Free State (previously Orange Free State); 5, KwaZulu-Natal (previously Natal); 6, North-West (previously northeastern Cape and southwestern Transvaal); 7, Gauteng (previously PWV); 8, Mpumalanga (previously Eastern Transvaal); 9, Northern Province (previously Northern Transvaal).

20 Proofs

Only page proofs are normally sent to authors. They should be corrected in red ink and be returned to the editor as soon as possible.

21 Reprints

Authors receive 100 reprints free. If there is more than one author, this number will have to be shared between them.

22 Documents consulted

Guides to authors of the following publications were made use of in the compilation of the present guide: *Annals of the Missouri Botanic Garden*, *Botanical Journal of the Linnean Society*, *Flora of Australia*, *Smithsonian Contributions to Botany*, *South African Journal of Botany* (including instructions to authors of taxonomic papers), *South African Journal of Science*.

23 Address of editor

Manuscripts should be submitted to: The Editor, Bothalia, National Botanical Institute, Private Bag X101, Pretoria 0001.

24 FSA contributions

24.1 Figures and text must conform to *Bothalia* format.

24.2 These articles will be considered as a full contribution to the *Flora of southern Africa* and will be listed as published in the 'Plan of Flora of southern Africa', which appears in all issues of the *FSA* series.

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Valuable books found

At the beginning of 1995, during stocktaking in the Mary Gunn Library, it was found that 10 rare Africana reference works, all bearing the stamp of the Department of Agriculture or the Botanical Research Institute, were missing. An intensive in-house search proved fruitless and the matter was reported to the South African Police Service (SAPS) in March 1995. A civil case dossier of theft (MAS 425/3/95) was opened by the Detective Branch of the Silverton Police Station in Pretoria. Letters were sent to local and overseas antiquarian book dealers to request their assistance in recovering these books. The list of missing works was published in this journal (Anon. 1995a) and in *Forum Botanicum*, newsletter of the South African Association of Botanists (Anon. 1995b). A reward was offered for information leading to the recovery of one or more of these books.

Some months later a book collector in Cape Town informed the Mary Gunn Library that four of the missing works (Bergius, Commelin, Jacquin and Linnaeus) were being offered for sale in a catalogue of a well-known antiquarian bookshop based in UK. Enquiries at the bookshop by an ex-South African botanist now living in England, revealed that they had purchased these four books for £2000.00 from a well-spoken South African visitor about eight weeks after the theft had been discovered. There was every indication that these were the books missing from the Mary Gunn Library. The stamps had, however, been carefully deleted and some minor repairs had been done with archival mending tape. By the time of the enquiry, three of the works had already been sold and only one was still at the antiquarian bookshop. One of the works had been sold to a well-known book collector in Cape Town, who handed it over to the SAPS to be used in evidence, should the investigation lead to a court case. The UK book dealer managed to repurchase the other two books.

The visitors' book of the Mary Gunn Library showed that a certain Mr J. van Niekerk a member of the public, had frequented the library at the end of 1994 and the beginning of 1995. This person was eventually arrested, his travel documents were impounded and he was later released on bail of R1000.00. This was the start of a long process to ensure a conviction by a court of law and the safe return of the books. Pivotal to the investigation was the testimony of the bookshop owner who had to identify the suspect positively as the person who had sold the books to him.

Due to numerous technical problems the court case had to be postponed from early 1996 to mid-1997. The book dealer was flown to South Africa at Government expense and the case finally served in the Pretoria Criminal Court on 8 May 1997. At the end of the proceedings the four valuable books used as evidence were

handed to the Librarian of the Mary Gunn Library for safekeeping. The case was postponed to 23 May 1997 for judgement. On this day Mr Johann Antonie van Niekerk (43) was found guilty of the theft of the four antique books from the Mary Gunn Library (Anon. 1997; Staff Reporter 1997). Magistrate R. de Vos who presided over the case concluded that the only suitable sentence was a fine in the form of a payment to the NBI in the amount of R14 000.00, a conservative estimate of the value of the books. Mr Van Niekerk's bail was extended to 30 July 1997, on which day an alternative sentence will be passed should he fail to pay the fine.

It is unfortunate that the NBI policy of providing free access to rare and valuable books to professional colleagues has been abused in this particular case. Therefore more stringent control measures had to be put in place to prevent a recurrence of this unfortunate incident. However, these measures will not unnecessarily hamper the work of *bona fide* researchers.

It took more than two years to bring about the safe return of four of the stolen books. However, the following six are still missing:

- LATROBE, C. 1818. *Journal of a visit to South Africa in 1815 and 1816*. Seeley, London.
- LICHTENSTEIN, H. 1812. *Travels in southern Africa, in the years 1803, 1804, 1805 and 1806*. Colburn, London.
- LINNAEUS, C. 1817–1830. *Systema vegetabilium*, 16th edn. Roemer, J.J. & Schultes, J.A. (eds). Cottae, Stuttgart.
- PETIVER, J. 1695. *Musei Petiveriana centuria prima*. Smith, Londini.
- THUNBERG, C.P. 1785. *Dissertatio botanica de Erica*. Edman, Upsaliae.
- THUNBERG, C.P. 1823. *Flora capensis*. Cottae, Stuttgart.

We hope sincerely that information will eventually be forthcoming to ensure that they, too, will be returned to the NBI.

Literature cited

- ANON. 1995a. Valuable books missing. *Bothalia* 25: 132.
- ANON. 1995b. Valuable books missing from Mary Gunn Library, NBI, Pretoria. *Forum Botanicum* 32: 8.
- ANON. 1997. Man beken hy het biblioteekboeke gesteel. *Die Beeld* 26 Mei 1997.
- STAFF REPORTER 1997. City man stole four antique books. *Pretoria News* 24 May 1997.

Errata in *Bothalia* 26,2 (1996)

PEROLD, S.M. Studies in the Ricciaceae of sub-Saharan Africa: a provisional key to the currently known species: 95–123.

p. 97:

34a Thalli large, *R. congoana* (Figure 11C, D)

should read *R. congoana* (Figure 11E, F)

35a Distribution *R. limbata* (Figure 11E, F)

should read *R. limbata* (Figure 11C, D)

p. 111:

Caption to FIGURE 11 **should read:**

FIGURE 11.—SEM micrographs of spores. A, B, *Riccia schweinfurthii*: A, distal face; B, proximal face. C, D, *R. limbata*: C, distal face; D, proximal face. E, F, *R. congoana*: E, distal face; F, proximal face. A, B, *Schweinfurth 1832* (H); E, F, *Volk 00747a*; C, D, *Oliver 8858*. A, B, E, F, $\times 450$; C, D, $\times 600$.

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